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THE CLASSIFICATION OF SNAKES.

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Owing to the absence of limbs and other points in which diversity is usually apparent, the classification of the snakes has always presented difficulties to the zoologist. An order which dates from Cretaceous time and has spread over the entire world, must have differentiated in structure, if its history has been like that of other orders of Vertebrata. Yet the researches of anatomists have only resulted in finding characters which define five suborders, and about a dozen families. Of the natural groups thus defined, one family, the Colubridæ, embraces three-fourths of the species, and is of cosmopolitan distribution. So long as this was the principal result attained, it remained clear that the stronghold of the order had not yet been taken.

The primary divisions above referred to, are defined by peculiarities of the skeleton, and these were mostly originally described by Johannes Müller. In the preparation of their Herpetologie Générale, Duméril and Bibron made a full study of the dentition. The results they obtained were important, but they were very far from expressing an exact and clear cut classification. The greatest defect of their definitions based on the teeth is that they too often fail to define. One type passes by easy gradations into another, so that in many cases it is im-

possible to determine what type a given dentition represents. In most cases it is clear that, among Colubrid snakes at least, no higher groups than genera can be predicated on dentition, and frequently not even these. Under such circumstances further structural characters had to be sought for if we are to have any clear idea of the affinities and phylogeny of this curious branch of the Reptilia. In any case no systematic arrangement can be regarded as final until the entire anatomy is known.

In 1864[1] I pointed out that certain snakes, notably the water snakes, have the vertebral hypapophyses continued to the tail, as in the truly venomous forms. Boulenger has since found this character in a good many forms which I had not examined, and which have no affinity to the water snakes. This character, while important, presents the same evanescent stages in certain types that the dental characters before noticed exhibit. It had long appeared to me that the only prehensile organs possessed by serpents, the hemipenes, might probably present structural variations expressive of affinity or diversity. In 1893[2] I examined these structures in many of the leading types, and was gratified by the discovery of a great many structural characters. In fact these organs exhibit a variety of ornamentation and armature beyond any part of the anatomy in the Ophidia, and I am satisfied that they furnish more important indication of near affinity than any other part of these reptiles yet examined. No one hereafter can be sure of the place of a serpent in the system until the hemipenis has been examined.

Still another part of the structure remained to be studied. The assymmetry of the lungs of snakes had often been noted by anatomists, but very little was known as to the range of variation. Accordingly the present year,[3] I undertook a study of the pulmonary organs. I was able to confirm observations previously made by Schlegel and Stannius, and to correct some others, and to add a great number of facts as to species not

[1] Proceedings Academy of Natural Sciences, Philada.

[2] American Naturlist, 1893, p. 477.

[3] Proceeds. Amer. Philos. Soc., 1894, p. 217.

previously examined. I cannot give here all the details observed, for which I refer to the papers quoted, but I give a general view of the results. One of these is that I am able to confirm the conclusion of Boulenger; i. e, that the Colubriform venomous snakes, the Proteroglypha, (cobras, Elapes, etc.), do not differ in any fundamental respect from the non-venomous Colubridæ, and that they can not be characterized as a suborder. The suborders then are:

Catodonta (Type Glauconia).
Epanodonta (Type Typhlops).
Tortricina (Ilysiidæ and Rhinophidæ).
Colubroidea (Peropoda, Asinea, and Proterogylpha).
Solenoglypha (Typical venomous forms).

The hemipenis is a projectile organ in the form of a hollow tube whose base is on one side of the middle line, and which opens into the anus. When retracted it lies beneath the tail, extending for a greater or less distance, and terminating in a cylindrical muscle. This has considerable length, and is finally inserted on a caudal vertebra. When the organ is projected this muscle is drawn forwards, so as to evaginate the tubular organ. Thus the inside of the tube becomes the outside, and the entire organ projects freely from its base anteriorly. It finds its way into the corresponding oviduct of the female (Plate XXVIII, v), and when once in place it cannot be tracted in most species, without invagination. This is performed by the contraction of the now internal retractor muscle. This is inserted on the internal face of the apex, and draws it inwards, so that it soon assumes the original ensheathed position beneath the tail. It cannot be withdrawn from the oviduct without invagination, because it is generally set with strong bony spines which diverge backwards. They have a perfect grip on the walls of the oviduct, and would in some instances lacerate that organ if the two bodies should be forcibly drawn apart. In other cases the hemipenis would be torn off at the base. Snakes sometimes partially project this organ, apparently in some instances for defence, as the spines are very pungent, and are sometimes curved like cats claws. Such at least would seem to have been the

case with two *Heterodon platyrhinus*, (spotted adders), which were brought to me with the organs projected so as to present the spines. They were caught by a cat, and were represented to me as fighting their captor in this and other ways. Snakes are, however, very careful not to present these organs fully evaginated so as to expose the delicate structures near the apex. I have never seen this to be the case in an alcoholic specimen, (with one possible exception), and I should judge that this was the general experience, from the figures given by authors. It is said that male snakes may be compelled to project the hemipenes by holding them before a fire, but I have not seen this.

The hemipenis of the Ophidia is traversed by a groove which divides the superficial investment to the internal integument (or external integument when the organ is retracted), which commences at the base internally, and soon turns to the external side of the organ and continues to its extremity. This is the sulcus spermaticus (s s in Plate xxvii). This sulcus is always bifurcated in venomous snakes, and I find it to be equally bifurcated in many harmless snakes (Figs. 2, 3, 7). The investing tissues may or may not correspond with this bifurcation. Thus the hemipenis may be more or less bifurcate (Figs. 1, 2, 7, 9, 10, 11). Schlegel states that it is bifurcate in venomous snakes, but it is not so in the sea-snake *Hydrophis hardwickii*, nor in *Bungarus semifasciatus*, *Hoplocephalus coronatus*, etc., while it is bifurcate in many non-venomous forms. Next to the bifurcation of the sulcus in importance, is the nature of the surface of the external investment (internal when retracted). In the most perfect types both venomous and non-venomous, this surface is reticulate like tripe, the enclosed areas forming calyces, which may have a suctorial function (Figs. 6, 9, 10, 11). Their borders are often papillose, and are sometimes so deeply divided into papillæ as to lose their original character. These papillæ may be the seat of osseous deposit, becoming bristles or spines, (sp), which become larger toward the middle of the length, and lose their mutual membranous connections. These isolated spines may extend to the apex, but they rarely extend to the base. The surface may, however, be laminate and not reticulate, and the laminæ may

be longitudinal (Figs. 4, 7) or transverse (Figs. 1, 2, 3, 5). In either of these cases they may not be spiniferous. The apex or apices of the organ may be furnished with a rigid papilla (Fig. 5) or awn.

In the Tortricina and Peropoda (the constrictors), the hemipenis is not spinous, and the sulcus is bifurcate (Figs. 1, 2, 3), and in the Boidae the hemipenis is bifurcate also, although in some genera (Xiphosoma, Ungualia), the branches are very short. The external integument is never reticulate, but is always laminate with elongate papillæ at the extremities, in Epicrates (Fig. 2), Xiphosoma, and Ungualia. The laminæ are pinnate from the sulcus as an axis, in Morelia, Enygrus, Lichanura and Eryx, and are transverse (flounced), in Charina (Fig. 3). In Ilysia they are pinnate (Fig. 1), with a few longitudinal plicæ below.

Similar gradations in the characters of the hemipenis are to be seen in the types of venomous snakes. Thus in the Proteroglypha this organ is spinous to the tip, on a calyculate basis, in Hydrophis, Elaps, (*surinamensis*); Dendraspis. It is reticulate at the extremities and spinous below, in Callophis (*bivirgatus*); Naja (Fig. 9); Acanthophis; Bungarus and Sepedon; the apex smooth in the two genera last named. In *Elaps nigrocinctus* the organ is smooth below, with spines at the apex.

In Solenoglypha the genus Atractaspis is spinous to the apex, apparently on a longitudinally laminate basis. In the Viperidæ and Crotalidæ the spines are on a flounced basis. The apices are calyculate in Bitis, Clotho (Fig. 10), and Vipera, and spinous in Cerastes. They are calyculate in Crotalidæ in Bothrops, Ancistrodon, Crotalophorus, Crotalus and Uropsophus (Fig. 11). In Crotalus (*durissus* of the Neotropical fauna), the papillae are not ossified; in all the other genera they are spinous.

The condition of knowledge as to the lungs of snakes was stated by Stannius, in 1856, as follows: "The detailed accounts as to the single or double character of the lungs leaves much to be desired. Among Ophidia Angiostomata there possess a single sack, Rhinophis and all Typhlopidæ

which have been examined; as to the Tortricidæ [Ilysiidæ], there are apparently species with two lungs (*T. xenopeltis*) [=*Xenopeltis unicolor*], and others with a single lung (*T. scytale*) [=*Ilysia scytale*]. Among Eurystomata, all the Peropoda (Boa, Python, Eryx) possess apparently two lungs. The Calamarina that have been investigated have one lung. Among Colubrina and Glyphodonta, there are great variations. All the Coronellæ of Schlegel possess, according to Schlegel, a single lung. I find the lung single in *Rhachiodon scaber* [*Dasypeltis*]. *Tropidonotus natrix* [*Natrix vulgaris*] has a very small rudiment of a second lung. *Coluber* [*Spilotes*] *variabilis* possesses, according to Schlegel, the rudiment of a second lung. According to the statement of Meckel, this rudiment is common in Coluber. The Xenodons have, according to Schlegel, a single lung (*X. severus* and *X. rhabdocephalus*). In Heterodon I find a rudimental second lung. The Lycodons, according to Schlegel, possess a single lung; as also do Psammophis and Homalopsis. In *Dendrophis colubrina* Schlegel found the rudiment of the second lung. In Dipsas, according te Schlegel, there are variations; but he states that *D. multimaculata*, *D. lævis* and *D. annulata* [*Sibon annulatum*], have but one lung. The Achrochordina have but one lung. Among Hydrophidæ I found in three species of Hydrophis the lung-sack simple. Meckel states that Platurus has a very small rudiment of a second lung. Among the remaining poisonous snakes there is an insignificant rudiment of the second lung in the Elapina and Crotalina; while the Viperina possess an entirely simple lung."

An examination of about one hundred and fifty species of nearly all types yielded the following results.

The snakes with rudimental posterior limbs (Peropoda), show in the character of their lungs, what they show in the rudimental limbs themselves, and in the hemipenis, the nearest relationships to the Lacertilia. They possess, with an exception to be noted later, two well-developed lungs, one of which is larger than the other. The smaller lung lies to the right side and ventrally, while the larger one lies to the left side and dorsally. In some species the dorsal and ventral

relation is more pronounced than in other. In the Colubroidea the right or ventral lung is generally present, but of very much reduced proportions, the usual size being from two to five millimeters in length (Plate XXVIII RL). It is connected with the other lung by a foramen which perforates the tracheal cartilage at a point a little beyond the apex of the heart, and opposite to the proximal part of the dorsal lung. It is sometimes connected to the dorsal lung by a short tube, in which cartilaginous half rings are seen in but two of the genera examined, viz., Heterodon and Conophis. The lumen of the rudimental lung may be lined by the same reticulate structure as is seen in the dorsal lung, or its walls may be smooth. In some Colubroidea the rudimental lung is absent, but such species are relatively few.

The dorsal lung may present proximally alongside of the trachea an auricle or pocket, and this is so developed in the genus Heterodon (Plate XXVIII), as to reach to the head, without communication with the trachea, other than that furnished by the normal portion of the lung. In the Solenoglypha, without exception, this extension of the dorsal lung is present, and extends to the head, and its lumen is continuous with the trachea throughout its length. The same structure exists in the genera Hydrus and Hydrophis; and also in the West Indian peropodous genus Ungualia, which differs besides from other Peropoda in having but one posttracheal lung. Finally the tracheal lung, as I shall call it, is distinct from the true lung in the water snakes Platurus and in Chersydrus. In the former of these genera the trachea is not separate from the lumen, while in Chersydrus it is distinct. It, however, communicates with the cells of which the lung consists in this genus by a series of regularly placed foramina on each side. There is no lumen in the tracheal lung of Chersydrus. In the blind burrowing Typhlops we have a still further modification of the tracheal lung. It is without lumen, and is composed of coarse cells of different sizes. These have no communication with the trachea or lung that I can discover. It has occurred to me that this structure, which extends from the heart to the throat, may not be a pulmonary organ.

I have referred to the dorsal and ventral positions of the two lungs. The rudimental lung is to the right of the dorsal lung in the Colubroidea, but in the Ilysiidæ it is to the left. It is quite questionable which lung this rudiment in this family really represents. In the Typhlopidæ, the single lung is on the right side and extends from the heart to the liver. It has the position of the rudiment lung of the Colubroidea, and may represent it. I cannot decide this question without further material. In Glauconia there is but one true lung, and this is ventral in position, and originates to the right of the heart, so that in this genus also it may represent the rudimental lung of the Colubroidea. There is here no tracheal lung or organ.

I have no doubt of the propriety of the separation of the Ungualiidæ from the other Peropoda, on account of its pulmonary characters. Nor is there any doubt in my mind of the necessity of the separation of the Leptognathinæ from the Xenodontinæ, on account of its large tracheal lung. The genus Heterodon differs very much from other Xenodontinæ, in the possession of an enormous diverticulum of the lung, but as it is not present in the allied genus Lystrophis Cope, its wider distinction may be a questionable proceeding. The very marked characters of the genus Chersydrus characterize the family, as well as the osteological characters. It remains to be seen whether the family I termed the Nothopidæ, but which Boulenger unites with the Chersydridæ, agrees with it in pulmonary characters. The remarkable tracheal lung or gland distinguishes the Epanodonta from the Catodonta, emphasizing the differences observed in the osteology of the skull.

The value of the rudimental right lung as a character of the Colubroidea is increased by my investigations. In only two genera have I found it present or absent, viz., Halsophis and Pityophis. I am not sure but that I may yet find it in the *P. melanoleucus*, where I have failed hitherto, but I am sure that it is present in some species of Halsophis and wanting in others. A natural group of American Colubrinæ, appears to be characterized by its absence, viz., Rhinochilus, Cemophora and Ophibolus; all genera with an entire anal shield. The development of cartilages in the bronchial foramen or tube of

the rudimental lung is not a constant character. I found it in one *Heterodon platyrhinus* and not in another; it is present in *Conophis pulcher*, but absent in *C. sumichrastii*.

The rudimental lung is often concealed from view and difficult to discover. The best test of its presence is the foramen which connects it with the trachea, which will generally be found piercing the cartilage of the latter near the apex of the heart. The rudimental organ may then be found by inserting a bristle, and observing its destination through the more or less transparent tissues. In but one instance have I found a rudimental lung without a connecting foramen, viz., in the Mexican *Ficimia olivacea*. On the other hand, the foramen may terminate in a small blind sac.

The pulmonary characters may be determined without much dissection. The position of the heart must be first ascertained, and a longitudinal median incision made in the abdominal wall. In all forms except the Epanodonta and Catodonta, the trachea will be found passing to the left side of the heart, and entering the lung near its apex. By splitting the trachea, not too near its abdominal border, on turning the free margin upwards as the snake lies on its back, the *foramen bronchiale* will be seen and its lumen can be explored. The trachea is concealed by the œsophagus, which must be drawn to the left side of the body in order to make the examination. The examination of the tracheal lung requires the division of the abdominal wall farther towards the head.

The tracheal lung greatly extends the surface available for blood aëration. This is necessary to snakes for the reason that the huge masses of food which they ingest, so compress the true lung that another organ is necessary. Most snakes whether they have a tracheal lung or not, have the pulmonary organ greatly elongated, so that while one portion is compressed by the contents of the alimentary canal, another part is free to function. The tracheal lung enables the snake to inflate the anterior part of the body. This is conspicuous in the true venomous species (Solenoglypha). In the same way Heterodon inflates its huge diverticulum. In the marine water snakes Chersydrus and the Hydrophidae, these organs serve as floats.

In the fresh-water snakes (Natricinæ) there is no tracheal lung. The hemipenis of this group is very characteristic, (Plate XXXVII fig. 8).

As an illustration of the modifications in classification necessary in view of the characters which I have observed, I give an analysis of the genera of the group which I have called the Xenodontinæ.[4] These genera belong mainly to the southern Hemisphere, and chiefly to the Neotropical Realm, a few genera occcuring in Africa and North America. The characters of the division are as follows.

Hemipenis with bifurcate sulcus spermaticus, and armed with well developed spines, which are developed from the marginal papillæ of calyculi, when the latter are present. Hypapophyses of the vertebræ generally present only anteriorly.[5]

A. Lung without large proximal diverticulum.

I. Apex of hemipenis without calyces or spines but with a membranous disc. (Disciferi Fig. 7),

♀. Rostral plate not recurved.

Hemipenis undivided, no scale-pits;	*Aporophis* Cope.
Hemipenis divided; no scale-pits;	*Opheomorphus* Cope.
Hemipenis divided; one scale-pit;	*Xenodon* [6]Boie.

♀♀. Rostral plate recurved.

Hemipenis divided; one scale-pit;	*Lystrophis* Cope.

II. Hemipenis transversely plicated (divided); (Flabellati).

Plicæ not pappillose; diacranterian;	*Helicops* Wagl.
Plicæ not pappillose; isodont;	*Pseudoeryx*[7] Fitz.
Plicæ pappillose; isodont;	*Rhabdosoma*[8] D. & B.

III. Calyculate, and not capitate (Calyculati).

♀. Hemipenis undivided.

Fusiform; isodont;	*Carphophiops* Gerv.
Colubriform; isodont; two nasals;	*Diadophis* B. & G.
Colubriform; diacranterian; one nasal;	*Amastridium* Cope.

[4] American Naturalist, 1893, p. 481.

[5] In Helicops they are continued to the tail.

[6] Including Liophis Wagl.

[7] Dimades Gray.

[8] Catostoma and Adelphicus are closely allied.

Colubriform; diacranterian; two nasals; *Hypsirhynchus* Gthr.

♀♀. Hemipenis double.

Fusiform; isodont; *Farancia* Gray.

Colubriform; diacranterian; no scale pits; *Dromicus* Bibr.

Colubriform; diacranterian; one scale pit; *Monobothris*[9] Cope.

Colubriform; diacranterian; two scale pits; *Halsophis* Cope.

IV. Capitate (or pocketed) (Capitati).

♀♀. Hemipenis undivided.

Scale pits single; scales smooth; *Pliocercus* Cope.

No scale pits; scales smooth; *Rhadinæa* Cope.

Scales keeled; prenasals in contact; *Tretanorhinus* D. & B.

♀♀. Hemipenis divided.

Rostral normal; isodont; *Ninia* B. & G.

V. Pappillose at apex. (African) (Papillati).

Hemipenis single; *Grayia* Gthr.

Hemipenis bifurcate; *Theleus*[10] Cope.

VI. Calyculate with spinous bands to apex. (Calycispinosi).

Subisodont; attenuate; *Uromacer* D. & B.

VII. Exclusively spinous to apex; (diacranterian). (Spinosi).

Anterior teeth wanting; *Enulius* Cope.

Anterior teeth present; anal divided; no scale pits; *Echinanthera*[11] Cope.

Anterior teeth present; anal entire; one scale pit; *Acanthophallus* Cope.

A A Left lung with a proximal diverticulum, extending to the throat.

VIII. Calyculate and capitate.

Rostral recurved; hemipenis divided; diacranterian; *Heterodon* Beauv.

Any one familiar with these genera will perceive that they are not represented in a linear series in the table. He will also observe that genera of probably not very close affinities

[9] Gen. nov. Type, *Dromicus chamissonis* Auct.

[10] Amer. Naturalist, 1893, p. 482.

[11] Gen. nov.; type *Aporophis cyanopleurus* Cope. This species is thought by Boulenger to be *Natrix melanostigma* Wagl; but that species is represented as unicolor above. The present species has three longitudinal bands, one median and one on each side.

are placed close together, as for instance Tretanorhinus and Helicops[12] and their associates. This is, however, a necessity of an artificial key and is not new in zoölogy. The characters presented by the hemipenis are more readily determinable, and are more constant that those to be found in any other part of the structure.

In further illustration of the same subject I present a synopsis of another tropical group, this time entirely American, which only differs from the Xenodontinæ in the grooving of the posterior maxillary tooth, i. e., the Scytalinæ.

I. Apex without calyces or spines, but with a membranous disc. (Disciferi).

Hemipenis divided; *Erythrolamprus* Boie.

II. Hemipenis transversely or obliquely plicate; (divided). (Flabellati).

No calyces; rostral plate normal; *Jaltris* Cope.

Calyces at apex; rostral plate produced; *Conophis* Peters.

III. Calyculate and not capitate. (Calyculati).

♀. Hemipenis divided.

Rostral recurved; *Rhinostoma* Wagl.

Rostral normal; pupil erect; *Oxyrrhopus* Wagl.

Rostral normal; pupil round; *Philodryas* Wagl.

♀♀. Hemipenis undivided.

Rostral normal; *Thamnodynastes* Wagl.

IV. Capitate (also calyculate). (Capitati).

Hemipenis undivided; colubriform; *Coniophanes*[13] Hallow.

Hemipenis undivided; fusiform; *Hydrocalamus* Cope.

V. Spinous to apex; (divided). (Spinosi).

Two nasal plates; *Tachymenis* Wiegm.

One nasal plate; *Tomodon* D. & B.

VI. Apex smooth, or with one row of spines; (divided). (Levi).

Urosteges one rowed; a band of minute calyces; *Scytale* Wagl.

Urosteges two rowed; no calyces; *Lygophis*[14] Tsch.

[12] Helicops is certainly to be placed in this family and has no relationship to the Natricinæ with which it has been hitherto associated.

[13] The penial characters of Coniophanes distinguish it from Erythrolamprus, with which I have proposed to unite it.

[14] Type *Lygophis elegans* Tsch.=*Dryophylax poecilostomus* Cope.

Comparison of this table with that of the genera of Xenodontinæ, shows that both present identical modifications of structure in the case of five of the subdivisions. Only two types, (V and VI), of the Xenodontinæ have not been found in the Scytalinæ; and one, (no. VI), of the latter group has not been found in the Xenodontinæ.[15]

EXPLANATION OF PLATES.

PLATE XXVII.

(From an unpublished Bulletin of the U. S. National Museum). Hemipenes of distinct types of Ophidia. The organ is split and the entire surface exposed. The student must remember that the lateral borders are artificial, and are continuous on the middle line behind the center of the figure in the projected organ. When the organ is bifurcate, but one branch is split; (figs. 1– 2–7–9–10–11).

Fig. 1. *Ilysia scytale* L. Brazil.
Fig. 2. *Epicrates angulifer* D. & B. Cuba.
Fig. 3. *Charina bottæ* Blv. Oregon.
Fig. 4. *Holarchus ancorus* Gird. Philippine Ids.
Fig. 5. *Oligodon subquadratus* D. & B. Java.
Fig. 6. *Bascanium constrictor* L. N. America.
Fig. 7. *Opheomorphus alticolus* Cope. Peru.
Fig. 8. *Natrix fasciata sipedon* L. N. America.
Fig. 9. *Naja haje* L. *melanoleuca* Hallow. W. Africa.
Fig. 10. *Clotho arietans* L. S. Africa.
Fig. 11. *Uropsopus confluentus* Say. Texas.

LETTERING.

ss. Sulcus spermaticus; *f*, flounces; *p*, papillæ; *cl*, calyces or calyculi (ruches); *l*, laminæ; *sp*, spines; *spl*, spinules.

PLATE XXVIII.

(From the Proceedings of the American Philosophical Society, 1894). Viscera of *Heterodon platyrhinus* Beauv. The

[15] Reflection has caused me to drop the major division Xenodontidæ, and to refer its two subfamilies to the Colubridæ.

heart is turned partly over, and the œsophagus is separated by being drawn to the left of the other viscera. One oviduct is split at the base so as to disclose the vaginal portion. In consequence the rectum is displaced to the right. The lettering is as follows.

Tr, trachea; *Car*, Carotid artery; *Hy* sheath containing hyoid cornua; *Oe*, oesphagus; *Vr*, vertebral artery; *A. P*, arteria pulmonalis; *L. L*, left lung; *R L*, right, (rudimental) lung; *H*, heart; *A R*, left aorta root; *V C*, vena cava ascendens; *L*, liver; *St*, stomach; *G B*, gall bladder; *Sp*, spleen; *F*, fontanelle of oviduct; *I*, intestine; *Ov*, ovary; *C A*, corpus adiposum; *K*, kidney; *Od*, oviduct; *R*, rectum; *U, ureter; *V*, vaginal portion of oviduct; *Cl*, cloaca.

LIMITS OF BIOLOGICAL EXPERIMENTS.[1]

By Dr. Manly Miles.

The proposition to test theories in evolution by direct experiments on living organisms which has been favorably noticed, and the numerous futile feeding experiments that have been made at the Government experiment stations, raise the question as to the probable limits of direct experimental methods in dealing with biological problems. The "whirligig of time," in connection with a certain uniformity in the outcome of the modified processes of nutrition and reproduction in a number of individuals, must be regarded as essential elements in bringing about the gradual aggregation and perpetuation of the minute changes in living organisms which we recognize as processes of evolution.

Aside from these significant factors, which cannot be neglected, the exceedingly complex conditions involved in all biological activities appear to be formidable difficulties to overcome in attempting a direct experimental verification of theories relating to the various agencies concerned in evolution, or, in determining the relative value of foods in the processes of nutrition.

Intelligent breeders of domestic animals have no doubts in regard to the heredity of acquired characters, which, in the light of their experience, they look upon as a fundamental principle in stock breeding and one of the most important factors in the available means of improvement. The direct proof of this principle by experimental methods must, however, be difficult, if not impossible, notwithstanding the cumulative and apparently conclusive evidence presented in the history of the improved breeds, and the experience of successful breeders who have recognized its importance in the improvement of their animals.

The dominant influence of other known biological factors may completely obscure well marked special characters that

[1](Abstract of a paper read at the Brooklyn meeting A. A. A. S., Aug., 1894).

have undoubtedly been inherited, as in the familiar facts of atavism, and they must effectually prevent the detection of the initial stages in the development of any new characters under investigation, which may in fact have been potentially transmitted for a number of generations.

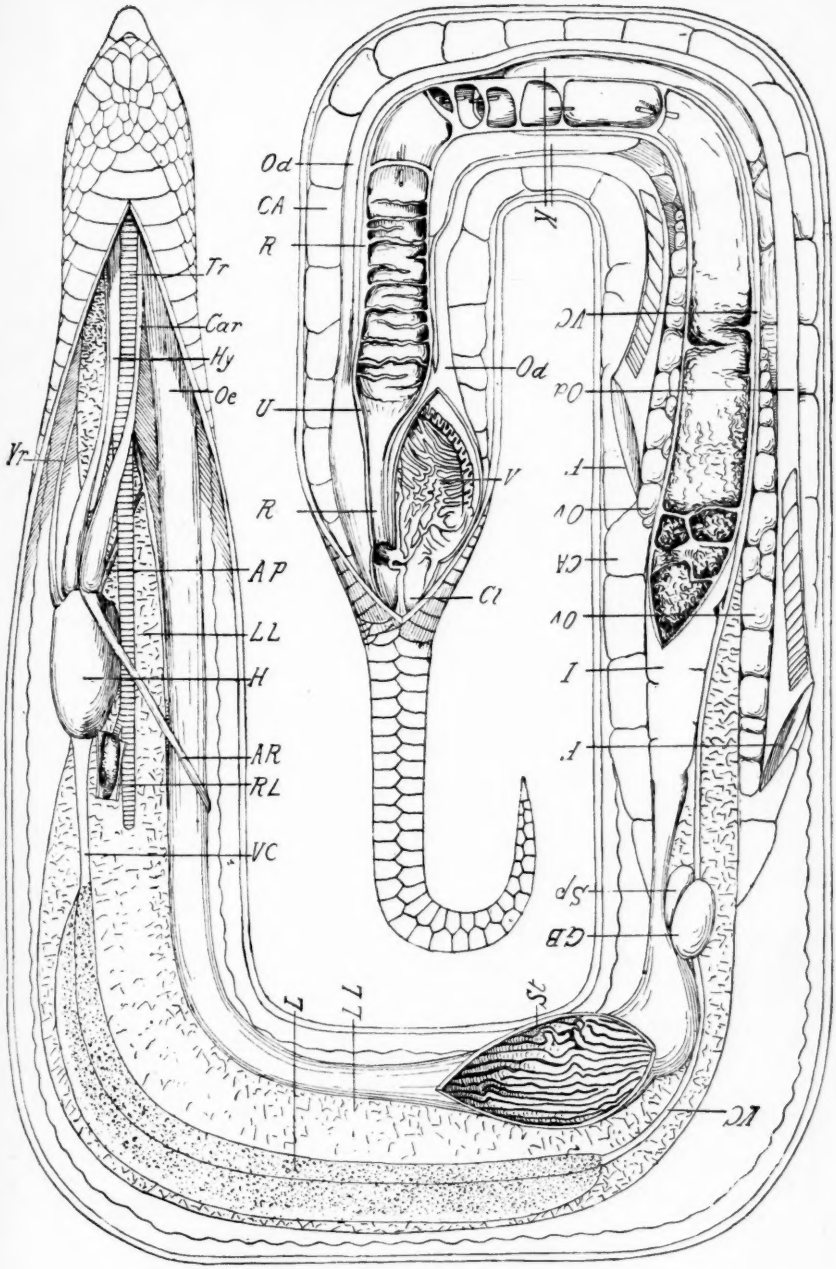
Reversion, prepotency, and the influence of a previous impregnation, are conspicuous obstacles in the way of tracing the immediate, or incipient indications of the inheritance of any particular acquired character which it may be desirable to perpetuate by judicious selections.

In many of the arguments relating to the heredity of acquired characters it appears to be tacitly assumed that each particular character is transmitted as an entity, regardless of its interdependent relations to other parts of the organism, and especially with the specific functional adaptations of the organs of nutrition which have made its development possible.

As pointed out in a paper read in Section F, at the Rochester meeting of the Am. Ass. Adv. Sci., physiological changes in the organism must precede any manifest modification of structural characters, and the transmission of a morphological peculiarity must, therefore, involve the transmission of the functional activities through which it has its origin. It was also shown that a habit or bias of the nutritive processes in a certain direction, may be transmitted for a number of generations without any visible morphological evidence of its existence, and that, in the lapse of time, it may lead to the development of obvious structural changes that are recognized as new characters. Experimental methods in biology are too crude to admit of a recognition of these preliminary steps in the development of new characters, which must be taken into account in making a satisfactory verification of any of the processes of evolution.

The artificial conditions to which our domesticated plants and animals are subjected, intensifies their susceptibility to variation, and there appears to be a constant tendency to reversion when any unfavorable conditions prevail in their treatment. Under ordinary management, repeated systematic

PLATE XXVIII.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selections are necessary in order to maintain the highest development of the most desirable characters, and a considerable number of individuals will be required to make any marked improvement in special qualities, as all do not respond alike to the artificial modifying conditions of their environment.

There are also individuals that retain a tendency to the prepotent transmission of the old race characters, notwithstanding the high development of the particular improved characters they possess, and a pedigree, showing that all known ancestors have had the desired qualities, is looked upon as a valuable index of the dominant inherited characters.

Even the best established breeds fail to exhibit the uniformity in their general characteristics which prevails in wild species that have been subjected to the more rigorous and discriminating processes of natural selection. The methods of artificial selection in the breeding of animals, are lacking in the inexorable consistency and comprehensiveness that characterize natural selection. The breeder of improved animals is unable to perceive all of their innate and acquired physiological tendencies, and his selections are made with reference only to the most obvious peculiarities, or qualities, and he overlooks and neglects many of the factors concerned in determining the correlated relations of the sum of their characters.

Feeding experiments to ascertain the relative nutritive value of different articles of food and the advantages of different methods of feeding, or, to determine the relative merits of different breeds, are especially liable to mislead, from the complexity of the problems presented—the small number of facts under observation—and the practical difficulties in the way of tracing the obscure relations of the most significant factors in the phenomena under investigation, to say nothing of the fallacious and obsolete chemical theories of nutrition that are too often adopted in a popular discussion of the results.

It is not my purpose to enter upon an exhaustive discussion of the limits of experimental biology, but to point out some

of the practical difficulties involved in its methods and results. Without further reference to particulars, it must be evident that biological activities have such complex interdependent relations, that theories relating to evolution cannot all be verified, or practical problems in nutrition satisfactorily solved, by direct experimental methods.

ABALONE OR HALIOTIS SHELLS OF THE CALIFORNIAN COAST.

MRS. M. BURTON WILLIAMSON.

Although the coast of California produces, as a rule, dull or sombre tinted shells, yet in one family of molluscs the Californian province stands preëminent. This family is composed of shells familiary known on the West Coast as Abalone or pearly-ear shells. Among scientists the shells are called *Haliotis* and the family Haliotidæ. In the size of all its species of Haliotidæ California rivals the world. Japan has one fine species *Haliotis gigantea* Chemnitz, that compares very favorably with the large shells of California, and this species is also represented on the West Coast of the U. S. by a variety. Another fine shell that compares favorably with the Californian shells is *Haliotis midæ*, the first shell of this family named by the great Linneus or Linnè, who described it in 1758. Australia also produces a large species, but for the most part shells collected on other coasts are small, ranging from four to one inch in length.

In the geographical distribution of this family, the "center of distribution is in the Australian and adjacent seas."[1] Besides those collected on the coast of California and Lower California, these shells are found as far north as Alaska, also on the coasts of Kamtchatka, Japan, China, Philippine Islands, New Hebrides, New Caledonia, New Zealand, Aukland, Id., Australia, Malay Archipelago, Ceylon, Red Sea, West Coast of Africa and at the Cape of Good Hope, Canary Islands, Mediterranean and Adriatic Seas, French and English Coasts of the Atlantic, and also at the Cape region of South America. It has often been remarked that "not a single species" has been "found upon either coast of South America, or upon the East Coast of North America," but, in 1869, Pourtales dredged a small Haliotis in 200 fathoms near the Florida reefs. The

[1]Pilsbry.

shell was named by Dr. Wm. H. Dall *Haliotis pourtalesii*, but in the great fire of 1871 in Chicago, this little specimen together with the "entire collection of Pourtales and Stimpson," was burned. In 1887–88 the U. S. Fish Commission Steamer Albatross dredged a number of shells on the West Coast, and, at the Galapagos Islands, in the Pacific, on the West Coast of South America, two specimens of *Haliotes* were dredged. And, what is remarkable, the shell found in Florida from the bed of the Gulf Stream and the one from the Galapagos group were pronounced by Dr. Dall the same species with scarcely a doubt. The latter did not contain the animal and was not quite one inch in length.[2]

In the Manual of Conchology, Mr. H. A. Pilsbry says of the family Haliotidæ in geologic ages: "Of the genealogy of the family little is known. A few fossil forms not differing materially from the recent ones, have been discovered in the Pliocene and Miocene and one in the upper Cretaceous of Germany. Others will probably be found when the Australian Tertiary and secondary strata are more fully explored." Two species of Abalones are found in the Quarternary or Plistocene formation in Southern California.

There are about 85 species and well defined varieties of shells in this family. On the Californian coast six distinct species are collected and also two or three varieties. Some of these species are found as far south as Cape St. Lucas, Lower California, and one species extends to Alaska; this is supposed to be a variety of the Japanese species, reaching the Californian coast by way of Alaska. The species is *Haliotis gigantea* Chemnitz var. *H. kamtchatkana* Jonas. Besides this northern species, *H. rufescens* Swainson, *H. fulgens* Philippi; *H. corrugata* Gray, *H. cracherodii* Leech and *H. assimilis* Dall are collected. The last named is a deep water species.

The generic name *Haliotis* was also given by Linné in 1758. It is from the Greek *hals*, sea and *ous* ear, but wherever these shells are found they have local names. In California they are popularly known as "Abalone," of "uncertain ety-

[2]See Preliminary Report on Albatross Mollusca by William Healey Dall, Curator Dept. Molluscs. (Proc. Nat. Mus., Vol. XII, 1889).

mology." Some writers think the name is of Spanish origin[3] but a well known Spanish scholar, one of the Jesuit Fathers, told me he thought the name was a "provincialism." It is said these shells are called "Awabi" in Japan. The local names given to the shell in different countries refer usually to the shape of the shell, and, being translated, mean ear-shell, ear-of-the-sea, Venus' ear, etc.; also on account of its nacreous lining, Mother-of-pearl-shell, and because of the holes in the shell, "six eyes." The beautiful nacre or mother-of-pearl in the interior of these shells, and the rich colors visible when the epidermis or outside layer has been removed, has given rise to color names. The most beautiful shell, in the interior, is the green abalone (*Haliotis fulgens*). The green and blue nacre is as effectively blended as the colors in a peacock, and is indiscribably rich in tone. The centre is especially rich in iridescent effect. This center is scientifically known as the "muscular impression" for it is at this place that the animal is firmly adherent to its shell, though young shells are not marked by this "area of the muscular impression." In some specimens it is horse-shoe-shaped. In an article on the Abalone Fishery in "The Fisheries and Fishing Industries of the U. S." (U. S. Commission of Fish and Fisheries 1887), Earnest Ingersoll says in referring to this muscle scar: "In aged specimens the part to which the muscle is attached is raised above the level of the rest of the interior and presents a roughened or carved surface of irregular shape, often fancifully imitative of some other object. The writer has seen one which thus contained a singularly correct profile of Napoleon I." Instead of the muscular impression being "raised above the level," my observation has led me to conclude that with age the muscle scar is, as a whole, depressed.

The red abalone (*H. rufescens*) does not receive its name from the color of its mother-of-pearl, as does the green shell, but from the red margin that outlines the aperture and the beautiful red displayed on the outside when the shell is decorticated by the use of acids or the grindstone. Another species (*H. cracherodii*, named for a Mr. Cracherod) when submitted

[3]From *aulon* or *aulone*.

to the same treatment shows a black exterior and this is the "black abalone." It is also called the "white abalone" in reference to its pearly interior and exterior, if the calcareous layers have been ground off leaving only the mother-of-pearl on the outside, as is often the case. A species with corrugations (*H. corrugata*) presents a reddish-purple color when ground off by a skillful workman. All these shells take a beautiful polish, but, while the shells are made more attractive to the popular taste, scientifically their value is depreciated after they fall "victims," as Carpenter expresses it, "to the grindstone and acids." Physicists tells us that the play of tints visible in the nacre or mother-of-pearl is caused by the action upon light of the tiny layers composing the nacre. "These layers are microscopically corrugated and their edges meet the rays of light and partly decompose them as do the rain drops in a rainbow producing a play of colors." (I once dissolved the inner layers of an abalone shell in muriatic acid, the dish was placed aside for several hours and on seeing it again I was surprised to find a beautiful sediment of iridescent mother-of-pearl; pressure was applied, and the play of colors was gone. The result was new to me at that time and was a pleasant surprise).

Typical shells of the Gastropoda (so named because the "under side of the body forms a muscular foot for gliding along"), the class to which abalones belong, are spiral in their form. Although these shells appear flat, a close inspection shows a well developed spire, but in most species, the spire is small and the basal or body-whorl is unusually developed and depressed, and this gives the shell an appearance as though it were only one valve of a bivalve, for which it has often been mistaken when seen by persons unacquainted with these forms. The shells have a row of open holes usually from five to nine, on one side, but these vary in number as the animal grows older; the holes close, until old shells have been seen with only one or two holes left open.[4] These holes are on the left side of the shell and through them the tentacles of the animal are often protruded. When the animal is resting upon

[4]A California Conchologist has a shell with *all* the holes closed.

a rock, a slight blow upon the shell often causes the shell-fish to adhere more firmly to the rock and at the same time discharge jets of water out of every hole. When entirely at rest the abalone adheres to the rock and is as completely covered by his shell as a watch would be under an inverted saucer, excepting that the five or more holes in the shell admit the entrance and exit of water. The large muscular foot with its epipodial ridge bordered with cirri extends outside of the shell when the animal is gliding along. This foot is to all appearances only a muscular expansion of the body. The animal has no operculum or trap-door, as in most families of this class, as it is like the limpet in having no use for an operculum. Abalones have a short head and eye peduncles. The gills or branchia, intestines, etc., are all on the same side of the shell as the holes, and the "columellar margin is produced into a flattened spiral plate," that forms a ridge sufficiently broad to protect all the digestive organs. The heart has two lateral auricles. The mantle is cleft at the row of holes extending thus "as far back as the last open hole." The odontophore[5] or radula is large, and the variety and size of the teeth on this lingual ribbon can be seen without the aid of a microscope. A section of the odontophore makes one of the most attractive mounts furnished by the radula of molluscs.

Reference was made to the fact that sometimes old shells had only one or two holes open when the animal was very old; when such is the case the shell is usually covered with a growth of vegetation, worms, or other molluscs. Whole colonies of *Serpulorbis* attach themselves to one shell making a very heavy load for a shell-fish to carry, even one so muscular as the abalone. Although they do travel somewhat, it is not improbable that with age the animal becomes more and more sedentary until almost incapable of locomotion. An abalone brought from the Pacific, about 24 miles away, after it had shown very little appearance of life, crawled from a pail of sea water, eighteen inches in one night, where it was found dead in the morning. The abalone marks his passage by a

[5]The ondontophore, sometimes called the "tongue" or "lingual ribbon" is set with rows of sharp siliceous teeth. In a large abalone it is about 3 inches in length.

trail of mucus in the same way that a land snail (*Helix*) leaves a trace of secretion in his wake. Besides the extraneous growth on these shells, they are the home of numerous pholads which burrow into the shell the same as into soft rock. The little domiciliary squatters often cause protuberances in the interior of the shell where the borer has drilled through the epidermis and calcareous portions into the nacre, which is always supplied sufficiently to resent the encroachments of domiciliaries. Dr. Robert E. C. Stearns of the National Museum has written an interesting paper on animals that encroach on the domain of others,[6] and it is illustrated with a plate showing these protuberances in an abalone shell. A red abalone that showed, on the inside, the raised nodule or protuberance indicative of the presence of a small rock-borer, on the outside of the abalone showed no perforation as usual, but, instead, there was a round depression of nacre, the pholad (*? Penitella parva* Tryon) *had been completely covered with nacre,* but a hammer and a chisel discovered the little bivalve that had been sealed up in his own domicile. As I broke the little pholad in getting it out of the abalone shell it could not be identified otherwise than doubtfully.

As pearls consist of coatings of nacreous secretion they are sometimes found in abalone shells. These will not compare with pearls found in the pearl oyster, as the latter are unrivalled. Pearls in abalones are often pear-shaped and green in color, in fact some of these so-called "pearls" are peculiar rather than beautiful. One fine pearl *baroque* (irregular) was taken from under the columella margin of a green abalone. It is the property of Mrs. Prof. Lowe of Pasadena, S. California, and is about $2\frac{3}{4}$ inches long; it is three-cornered in shape, and at the widest and thickest part it is $2\frac{1}{4}$ inches around.

As is well known the habitat of abalone is among rocks, where, at *very low* tide, they may be found huddled together in a corner of a rock in a rock pool, or hedged in between fissures of immense rocks, always as though hiding from the

[6]On certain Parasites, Commensals and Domiciliaries in the Pearl Oyster, etc. (Smithsonian Report, 1886, pages 339–344, with three plates).

light. Their dingy exterior almost of the same color as the rocks on which they rest, make them scarcely noticeable save for the protuberances that are visible on the rocks from which they are very difficult to remove, a trowel or wedge, etc., being necessary to dislodge them. Fishermen and Chinamen are the principle collectors of abalones. To illustrate the strength of muscle developed in this shell an anecdote is sometimes told of a man who was collecting some shells, when one of the shell-fish drew his shell so closely to the rock the man's hand was securely pinned to the rock and he was drowned. At one time the man is a Mexican, at another a Chinamen; the occurrence at one period is at Santa Barbara, at another San Pedro, but, the story always begins with "I have heard, etc." Any one who has collected these muscular fellows would be wary about allowing even a finger to be in close proximity to the shell, nor is it necessary to do so, the trowel or tool used to dislodge the shell is all that is needed. That men have lost their lives while collecting these shells there is no doubt at all, as the tide sometimes comes with fearful force on the slippery rocks. Three or four years ago the local papers reported the drowning of a young fisherman while getting abalones at San Pedro. Last spring a San Francisco paper told how a coyote was entrapped in a Haliotis which the coyote found partly raised from a rock, and, on inserting his muzzle underneath to secure a breakfast, the abalone had "closed down on him and kept him a prisoner."

As an article of food it is the general impression that the Chinese are the only consumers, but this is a mistake, although as an article of commerce only the Chinese seem to value it highly. At a lonely "point" in one of the Palos Verdes Hills we once found a large number of abalone shells around a deserted camp-fire, the fish had evidently been cooked on the fire, then eaten from the shell by the fishermen. A slice of abalone, before it is cooked, laid upon a platter might easily be mistaken for a slice of fish. They are pounded before cooking. As a soup this shell-fish is said to be very palatable and it has frequently been mistaken, by the uninitiated, for clam soup. As an export the fish is dried after being removed

from the shell. I have seen three and four dozen abalones dried and strung on a cord, in Mexican grocery stores, hung beside dozens of strings of red peppers or chilles so gratifying to the Mexican palate. Abalones, when dried, have the appearance of leather, excepting that they are oily in their appearance. In shape they are nearly oblong and two or three inches thick. The great muscular foot slopes backward over an inch before it is enlarged by the epopodial ridge with its numerous cirri, and this contraction is noticeable in the dried fish.

As an article of commerce the shells are of considerable importance, or rather have been, as it is said, the immense traffic has almost "stripped the coast as far south as Cerros Island," Lower California. Three hundred tons are said to have been shipped from the coast in one year. Fifty tons being handled by one man in a month's time. "The greater portion of these are (in 1889) collected on the coast of Lower California. The Chinese are the principal gatherers, notwithstanding they are probibited by the Mexican laws. The shells are sold at $20 to $35 per ton, according to the quality."[7] When shells are sold by the bulk there is always a large percentage of dead and imperfect specimens, as the best shells are picked out and sold to retail dealers on the coast. A shell that is perforated by worms or molluscs is of no value as a polished shell. When the animal has been removed from the shell and the latter has laid on the beach subjected to the sun and the weather, the mother-of-pearl becomes dull and unattractive, and such shells are known as dead shells.

In California dead shells collected on the beach are often used, instead of stones, for rockeries, and also as borders for flower beds. It would be impossible to enumerate the ornamental uses to which abalones are applied. "In China they are broken up and used for inlaying in connection with lacquer work for which the Chinese are famous. The Mosaics of Europe are often adorned in the same way." Although the pearl oyster (*Maleagrina margaritifera*) is used where a pearly-white tint, such as seen in the pearl handles of silver table

[7]The West Amer. Scientist, April, 1889, p. 12.

knives, etc. is desired, yet in mosaics and work enriched by a display of iridescent tints the nacre of abalone shells stands preëminent. Inlaid work is so universally used that an enumeration of articles ornamented in this way is unnecessary, but mention may be made of one use of these shells in lacquer that to an American or European may seem unique; its use in a "pillow end." When we think of a pillow we imagine a billowy roll all done up in white, but, a Japanese or Korean has a very different idea. In the Korean collection in the U. S. National Museum are some small pillows and the following description is given of the ends of two of them:[8] "Pillow end (Be-ga-mo). Circular piece of wood, lacquered, incrusted with Haliotis shell. Figures represent a tiger under a pine tree; along the border is a band of arabesque." "Pillow end (Ja-ga-be-ga-mo). Disk of wood fastened in the end of a cylindrical pillow case, in black lacquer with Haliotis shell. Subject, the great dragon rising from the sea into the sky in the spring season." In describing these pillow ends Mr. Walter Hough says: "The Korean pillow is a cylindrical case stuffed with hair or rice straw. It has ornamented ends. The first one mentioned is 8¼ inches in diameter, but is 'not part of a regular pillow,' being used as a 'arm-rest.' The second one is 8 inches in diameter."

As a medium for trade among the Aborigines of North America, abalones have been highly esteemed both for their beauty and importance when used as shell money. The shells in the latter case being cut "into oblong strips from one to two inches in length, according to the curvature of the shell, and about as third as broad as long." These were strung on a string and were used both as money and ornaments. Dr. Robert E. C. Stearns, Adjunct Curator of Molluscs in the National Museum, has written a comprehensive monograph upon the use of shells by the Indians, entitled "Ethno-Conchology, a study of Primitive Money," and in it is figured money made from abalones, which the Indians termed "Uhllo." In the recent excavations at the old historic town of

[8]Report of the U. S. National Museum, 1891, page 465.

Pachacamac, near Lima, Peru,[9] squares of mother-of-pearl were found in the graves of the Incas. These squares are only half the length of those figured in Dr. Stearns' paper. The pieces look like the nacre of abalones and each square has two holes drilled in it. As the graves, or burial place of Pachacamac is supposed to be over four hundred years old, these shell pieces are very interesting, revealing also the fact that the Incas considered shell ornaments valuable enough to be buried with their bodies. As these strips of solid silver, done up in a loosely woven cloth, were found in a mummy's hand, the pieces of shell were evidently not used as money, the silver having been cut for that purpose.

Dr. Stearns instances the purchasing power of an abalone from the fact that in New Mexico a horse had been traded for a shell. I was relating this incident to a friend who had spent some years with the Pueblos in New Mexico, and my friend said that that was not surprising, as, when she first went to New Mexico, some years ago, her brother bought her a good Mexican horse for $6.00, and the Indians were always as glad to receive attractive shells as money. This would not be a very extravagant price for an Indian to pay for a fine Haliotis, as a shell dealer once listed to me *H. fulgens* as high as $10.00. Whether any conchologist paid such price is unknown to me, but, a red abolone, when decorticated, has sold in Los Angeles for $5.00, but it was a large specimen and beautifully polished.[10] Like other commodities abalone shells are variable in price according to the demand, as well as quality.

[9]In the private collection of C. F. Lummus, Los Angeles, Cal.

[10]It is related that as high a price as $25.00 has been asked for an abalone having a peculiar muscular impression outlined in the interior of the shell.

THE DURATION OF NIAGARA FALLS.

By Dr. J. W. Spencer.[1]

For the past century Niagara Falls has been considered a time measurer, but its greatest interest has risen since the growth of our knowledge of the Ice Age on account of the expectation that in some way it can be made to tell something of the date of that period and indirectly of the advent of man, or his restrictions on account of the glacial conditions. The paper of which this is an abstract was primarily a physical study, setting forth the changing episodes in the history of the falls, and computing the age of the river, but leaving to others the application of the results in the question of early man.

The method of determining the age of the falls is the application of the mechanics of the river to the various conditions during the changing episodes of its history, in a large measure discovered by the author during the last fifteen years. The investigation differs from those of other writers who have simply divided the length of the chasm, excavated by the retreating falls, by the imagined or measured rate of the recession of the cataract. At a glance, even the most superficial reader can understand that if the height of the cataract be first reduced to one-half, and then again doubled, or if the volume of the river be reduced to one-fourth, such variations are bound to produce as great changes in the rate of recession as are indicated by the mechanical laws; and that if the conditions have not always remained constant, then the present rate of retreat has not always obtained—sometimes slower and sometimes faster. It is this question that the paper considers for the first time. In the much written, but, until recently almost unknown, history of Niagara River, we find that an approximately correct estimate of the age of the falls was made half a century ago by Lyell, upon a conjecture of the rate of re-

[1] Abstract of a paper read before the Am. As. Ad. Science at Brooklyn, August, 1894.

cession now known to be wholly erroneous. Again, within the last eight years, there have been several writers who have been using corrected cöefficients of retreat, still their results are more inaccurate than the guesses, as to the age of the falls, made a hundred years ago, yet they may be said to have approximated the truth within their observations, but the observations have become enlarged.

A hundred years ago, Andrew Ellicott estimated the age of the falls at 55,000 years. Forty years later, Bakewell made the falls about 12,000 years old. Over fifty years ago, Lyell conjectured the age at 35,000 years, and this estimate was commonly accepted until about a decade ago. The foundations for the measurements of the retreat of the cataract were laid by Professor James Hall, when he made the first preserved instrumental survey of the cataract in 1842. Since then, measurements have been repeated in 1875 by the Lake Survey; in 1886 by Professor W. S. Woodward, and in 1890 by Mr. Aug. S. Kibbe. From these surveys the mean rate of modern recession of the falls is found much more rapid than was formerly supposed, as it amounts to 4.175 feet a year, and if the history of the falls had been uniform, then the age would have been only 9,000 years—not so different from the guess of half a dozen years ago, which took the maximum medial retreat of the cataract, and made the age only 7,000 years. Had the gentlemen taken the mean rate as then known, which the scientific methods dictated and since supported by the action of the river, they should have made the age of the falls 11,000 years, near which estimate some did. This point is noticed on account of many secondary writers finding the number 7,000 years as agreeable to their theories.

Owing to some structural variations, I have taken 3.75 feet a year as the mean rate to be adopted for the retreat of the falls mechanically applied to the different conditions of the river. These have been occasioned by the changing heights of the falls and the volume of the water. With regard to the latter point, it has been found that for three-fourths of the duration of the river, the drainage of Lake Huron and the upper lakes was by way of the Ottawa River, and not by way

of Lake Erie and the Niagara. Under these conditions only $\frac{1}{11}$ of the present discharge of the Niagara River cascaded over the falls. The episodes of the river are as follows: First episode: water descending 200 feet, volume $\frac{3}{11}$ of the present (when the falls was of about the magnitude of the present American cataract), chasm excavated (as shown by the position of terraces) 11,000 feet; time required, 17,200 years. Second episode: descent of the river in a series of three cascades aggregating 420 feet at first with only the Erie drainage (during the recession of 3,000 feet) and afterwards the present volume of water (when the recession amounted to 7,000 feet) duration 10,000 years. Third episode: river descending 420 feet in one cascade with the present volume; time required, for the recession of 4,000 feet, only 800 years. Fourth episode was somewhat complicated, with the water mostly descending 320 feet, and during this condition the falls have receded 11,500 feet, and required a period of 3,000 years. Thus the age of the falls has been computed at 31,000 years. But at the beginning, the river flowed from lake to lake without a falls, and this time has been taken as 1,000 years; accordingly, the age of the river is computed at 32,000 years. The record of the changing levels may be seen in the deserted beaches now high above the lakes which have already been described in scientific journals. The investigations doubtless contain some errors which may be corrected in the future, but in the history of the lakes the present computations are very strongly confirmed by much cumulative evidence so that the present results appear to be approximately correct. It is further estimated that with the earth movements continuing as at present, the end of the falls will be effected by the change of the drainage from the Niagara River to the Mississippi, by way of Chicago, owing to the rise of the eastern rim of the Erie basin above the barrier now separating the lake waters from the Mexican drainage. With the present rate of elevation continuing, the future life of the river ought to be 5,000 or 6,000 years.

In regard to the relation of Niagara River to the Ice Age, I estimate that the lake epoch commenced from 48,000 to

64,000 years ago, and that for several thousands of years before the birth of the river there was open water far northeastward of the river. Some writers think that the St. Lawrence Valley was obstructed by ice until a late date. This is a question to be determined; but however it may be, there has been free communication for the drainage of the Ontario basin for at least 14,000 years. Whether the end of the Ice Age were 60,000 or 14,000 years ago, all glacial obstructions had retreated to at least from 400 to 600 miles to the north and east of the Great Lakes fifty milleniums ago. The lake region was roamed over by mastodons, elks and beavers, but we do not know of the presence of man. If such be found, anthropologists will have all of these years to consider in fixing the antiquity of man. The story of Niagara River forms an interesting chapter in the physical growth of the lakes, and gives us an approximate idea of the duration of the lake epoch which was characterized by the last touches in the fashioning of the continent, and fixes the height of the Ice Age a very long time ago.

One point more should be noticed. An error has prevailed for fifty years in that it was supposed that the ancient Niagara drainage was by way of the Whirlpool, (St. David's) Ravine. This has been found erroneous, owing to the occurrence of rock across the Whirlpool Ravine at an elevation of about 170 feet above the surface of Lake Ontario.

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RECENT LITERATURE.

The Colorado Formation.[1]—This memoir by T. W. Stanton is published as Bulletin, No. 106 of the U. S. Geol. Survey. It comprises the descriptions and illustrations of all the species that can now be assigned to the fauna, thirty-nine of which are believed to be new to science. In an introductory chapter the author defines the Colorado formation, describes local sections, and gives faunal lists that show the vertical range and areal distribution of most of the species. This formation has been recognized by means of its characteristic fossils in Iowa, Minnesota, the Dakotas, Nebraska, Kansas, Colorado, Wyoming, Montana, Utah, Arizona and New Mexico. Equivalent strata exist in Texas and the adjacent regions, and over large areas in British America. As yet it is unknown east of the Mississippi, but it may have an equivalent on the Pacific coast, as one of its most characteristic fossils, *Inoceramus labiatus* is reported from the Upper shales and sandstones of the Queen Charlotte Island.

Mr. Stanton considers the fauna, as a whole, the taxonomic equivalent of the Turonian, as first pointed out by Cope.

The memoir is richly illustrated with 45 page plates of drawings carefully finished in detail.

Our Native Birds of Song and Beauty.[2]—This work by Mr. Nehrling is designed to awaken a love for nature among young people and particularly to interest them in bird-life so that they will not only protect it, but they will also study the habits and learn the haunts of birds with the view of fostering them by providing suitable nesting-places. It is issued in quarto form and the publishers have left nothing to be desired in the way of paper, type, and all that goes to present a book in an artistic form. The complete work will be a treatise on all the native North American Birds from the Thrushes to the Parrots. Vol. I, which is now at hand, carries the reader through the Swallows. An introductory chapter contains brief remarks on birds prized for their song or beauty, their habits, migration, their utility, their enemies, their protection; and the acclimatization of exotic birds. Then follow

[1] The Colorado Formation and Invertebrate Fauna. By T. W. Stanton. Bull. of the U. S. Geol. Surv., No. 106. Washington, 1893.

[2] Our Native Birds of Song and Beauty. Vol. I. By Henry Nehrling. Milwaukee, 1893.

descriptions of species and with each description the author gives an account of the habits and habitat, based chiefly on his own observations. In every case the local name is given in addition, and no effort is spared to combine scientific accuracy with popular diction. The plates by Ridgway and Mützel are admirable specimens of color printing.

Cartailhac's Prehistoric France.[3]—This work forms one of the Bibliothéque Scientifique Internationale Series, and like the rest of that set aims to embody the leading facts of the subject treated in brief essay which shall be at once both popular and scientific. M. Cartailhac's opening chapter is a history of the progress of the science of archeology, and contains a resumé of the important discoveries made in France. Then follows a discussion of the evidence for the existence of preglacial man, and a presentation of the undoubted facts concerning his appearance during early Plistocene. Under the head "artistic manifestations," are described the drawings and sculptures by primitive man, and the conclusions drawn from a comparison of the work with that of uncivilized man of the present day. A chapter on human bones discovered in the Alluvium and another on the mortuary customs as evidenced by the position, condition and surroundings of the skeletons discovered in caverns and burial-places closes the history of Paleolithic man.

Of Neolithic man M. Cartailhac makes a longer story. The grottoes, both natural and artificial, used as sepulchres, and the strange megalithic crypts, are very fully described, together with the funeral rites of the ancient Gauls. Ethnographic comparisons are made with living races, particularly as to the custom of erecting stones as monuments. Finally a discussion of the type of Neolithic man as revealed by the Cro-Magnon and other skulls found within the last few years brings to a close this interesting work on prehistoric man.

The volume forms one of the series edited by M. Lanessan, and it is of importance as furnishing a review of what has been discovered in that richest of all fields, France.

Report of the U. S. National Museum for 1892.[4]—This report comprises the Reports of the Assistant Secretary of the Smithsonian Institution upon the condition and progress of the Museum; Reports of the Curators; Paper's illustrative of collections in the Museum; A Bibliography; and List of Accessions. Shufeldt's Paper on scientific

[3] La France Préhistorique d'aprés les Sépultures et les Monuments. Par Emile Cartailhac. Paris, 1889.

taxidermy is beautifully illustrated. The author criticises the results attained by workers in the Museum, viewing the subject from the standpoint of an artist and biologist. Other important and interesting papers are Dr. White's discussion of Biology in its relation to geological investigation, and a description of Japanese Wood-cutting and Wood-cut Printing by T. Tokuno, chief of the Bureau of Engraving and Printing of Japan. This paper is also finely illustrated.

Marsh on Tertiary Artiodactyla.[5]—In this paper we have another characteristic production of its author. Thirteen alleged new species, three alleged new genera, and three alleged new families, are named. To point out how far they are described, and are not duplications of other work, is the object of the following pages. The three "new" families are not described at all, not a single character being assigned to any of them. No reasons are given to show that they differ from each other or from families already known. The three new genera are described, but are not compared with genera already known out of North America. One of them (Agriomeryx, p. 270) is identical with the Coloreodon Cope, described in 1879[6] and figured in 1884 and 1888[6]. In addition to these three genera, references are made to nine other alleged genera named by the author in previous publications. Taking these up seriatim, the first in order is called Eohyus, which name was used without accompanying description in an address delivered by Prof. Marsh and published in 1877. The introduction of this and other new names in this way in that address gave them no authority, and other names applied to the same types at subsequent dates, if accompanied with a description, would necessarily be used. But if not so replaced, this rehabilitation after seventeen years, should be such as to satisfy the rules of nomenclature. But what is now offered to us? The only diagnosis of Eohyus vouchsafed to us, is that "the type specimen is a last upper molar and the characters of its crown are well shown in the figure," which accompanies the text. This will scarcely do as a generic diagnosis, and no other specimens represent the species and genus! Yet on the strength of this material he bases the "new" and undefined "family Eohyidæ." The specimen comes from the Wasatch of New Mexico. He then describes most imperfectly, and without figure, an alleged second species from the Puerco formation,

[4] Report of the U. S. National Museum for the year ending June 30, 1892. Washington, 1893.

[5] Description of Tertiary Artiodactyles by O. C. Marsh. Amer. Journ. Sci. Arts, 1894. Sept., p. 259.

[6] Proceedings American Philosoph. Society.

which he, as usual, calls the lower Wasatch, (again in defiance of the rules) thus assuming that a genus of this group is common to the two formations, an assumption only to be made on far better evidence than is here offered. He next states that the name of the Puerco genus Periptychus Cope is "preoccupied," but does not point out how or where. Scudder's Index shows that a division (not a genus) of Lepidoptera has been called Periptyches, which is not preoccupation. The entire proceeding is an attempt to make something out of nothing and is unworthy of a place in a scientific Journal.

The next genus mentioned is called Parahyus Marsh, which name was given in 1876. Osborn has regarded it as identical with Achænodon Cope, 1873, and no characters have been assigned which will distinguish them. The next name is Homacodon, which was given by Marsh without generic diagnosis in 1872. Two "new species" are named, but not described, but they are supposed to be introduced to science by figures of two astragali! The author asserts that the genus which I described, also in 1872, under the name of Pantolestes, includes species of "Homacodon." As the type of Pantolestes is from the same horizon as Marsh's specimens, it is probable that Homacodon is a synonym of that genus. If so, the superior molars are quadritubercular, since Marsh so figures them in the present paper. It is, therefore necessary to give the tritubercular form from the older Wasatch horizon another name. For this genus, whose type is the *Pantolestes brachystomus* Cope, I propose the generic name of Trigonolestes. The proper description of the *Homacodon vagans* by Marsh in 1872 would have prevented the reference to the same genus of the Wasatch forms in 1884.

The next genus proposed is Nanomeryx, which is defined. The type and only species is called *N. caudatus*, but is not described, except by the statement that it is half as large as the *Pantolestes* (*Homacodon*) *vagans*, and by reference to figures of the inferior end of the tibia, and the astragalus. Rather hard lines for paleontologists who shall hereafter desire to identify the species! We next reach the so-called genus Helohyus, which Marsh on a previous occasion alleged to be identical with Phenacodus. He does not repeat this statement in this paper, but says that it is suilline and therefore a member of another order. Two figures show that the two forms are also very distinct as to dentition. The name was originally proposed by Marsh in 1872 without generic diagnosis, and no diagnosis is given now, so that the field is still open to any one who may be able to properly characterize it. The abortion of another generic name given by himself by its union with "Helohyus," is a step made by the author in the right direction.

Our author next enumerates certain selenodont Artiodactyla from the Eocene system. Here we have an attempt to rehabilitate three generic names, enumerated, but not sufficiently or not at all described in the address of 1877 before referred to, and without mention of type species. The first of these (Eomeryx) has been since well described by Scott and Osborn, (in 1889), who show that the form is allied to Oreodon. Their name, (Protoreadon), has the right of first description and should be retained. The next genus, Parameryx, is described sufficiently to ensure its adoption, if it is distinct from the various allied European forms, with which, as usual, no comparison is made. The species ("*P. laevis*") is not described, but future students are expected to identify it from two figures, one of an upper molar, and the other of the astragalus. A second supposed species is very insufficiently described. Unfortunately for the adoption of the name Parameryx, the genus was, according to Marsh, described by Scott and Osborn in 1889 under the name of Leptotragulus. This publication contained the first description of the genus, hence the latter name must be retained. The third name of the address was "Oromeryx." It was not described, nor was any type species mentioned. The omission as to description is now supplied, but specific and family characters are confused by being mixed with the generic.

Under the head of Miocene Artiodactyles, we find the genus Coloreodon Cope redescribed under the name of Agriomeryx as already noted. The only species named is not described, but a part of the skull is figured, which does not offer any difference of specific value from the *C. ferox* Cope. The next form referred to is the suilline genus named but not described by Marsh in 1875 as Thinohyus. It has been impossible hitherto to locate this genus from Marsh's paper, but the figures of a few molar teeth now given throw some light on the subject, but as hitherto, no distinct description of the genus is given. Next follows a fuller description than usual of a new species of Leptochoerus Leidy. The author says that the molar teeth resemble those of the alleged genus Helohyus, but the figures show that they are very different. A suspicion of this seems to have been present to the author, who proposes to place the genus in a new family the "Leptochoeridæ," which as usual, he does not characterize. The last feat of Prof. Marsh which I shall notice, is that of naming a supposed new species of Procamelus on a figure of the calcaneum only! He states that the bones were found in the Pliocene of the John Day region of Oregon, meaning probably Loup Fork. Pliocene beds do not contain the genus Procamelus.—E. D. Cope.

General Notes.

MINERALOGY.[1]

Crystallization of Enargite.—Pirsson[2] has studied enargite from two new Colorado localities, viz., the Ida Mine, Summit District, and the National Belle Mine, Red Mountain. At the former locality the mineral is deposited in cavities left after the kaolinization of feldspar phenocrysts in porphyry. These crystals are tabular parallel to $\infty P\bar{\infty}$, and are bounded by the forms $\infty P\bar{\infty}$, oP, ∞P, and $\infty P2$. At the latter locality two types of crystals are found. One of these is in thick, striated prisms bounded by the same forms as the Ida Mine crystals and sometimes in addition $P\bar{\infty}$, $P\infty$, $\infty P\frac{3}{2}$, and another brachydome. The second type of crystals from this locality is tabular parallel to the base and shows hemimorphic development. The forms observed on this type are oP, $\infty P\infty$, ∞P, $\infty P3$, $P\bar{\infty}$, $\frac{3}{4}P3$.

Crystallization of Scolecite and Meta-scolecite.—Rinne[3] has investigated crystals of scolecite from Iceland and shown that the mineral crystallizes in the rare inclined-faced hemihedral division of the monoclinic system. This fact was developed by etching and by study of the pyroelectric properties. The front faces of the prism have different etched figures from the rear faces, while in twinned crystals with the twinning plane the ortho-pinacoid, front and rear faces of the prism have the same figures. In simple individuals the front and rear faces are pyroelectrically positive and negative poles respectively. In twinned crystals all prism faces are positive and a negative zone follows the twinning line on $\infty P\bar{\infty}$ with neutral bands on either side.

When crystals of the mineral are heated much above 120° C they become cloudy, and the crystal structures seems at first sight to be lost, but by brightening up in oil it is found that a molecular rearrangement has taken place. This new mineral Rinne calls meta-scolecite. The inclined-faced hemihedrism of the monoclinic system is retained, but a remarkable revolution of the molecular groups through

[1]Edited by Dr. Wm. H. Hobbs, University of Wisconsin, Madison, Wis.
[2]Am. Jour. Sci., (3) xlvii, pp. 212–215.
[3]Neues Jahrb. f. Mineral., etc., 1894, II, pp. 51–68.

an angle of 90° about the 'c axis has taken place. The ortho-pinacoid has become the clino-pinacoid and vice-versa. The twinning plane of twinned crystals has undergone the same revolution. By heating crystals beyond the temperature required for producing the first meta-scolecite, the double refraction of the substance steadily decreases and the symmetry approaches more and more closely to the orthorhombic. Below red heat the structure breaks down. As scolecite possesses three molecules of water of crystallization, Rinne suggests that the first meta-scolecite contains two, the second one molecule of crystal water, the crystal structure being lost when all the water has been removed.

Crystallization of Herderite.—Penfield[4] has made a study of herderite from the known localities as well as from a newly discovered locality at Paris, Me. The herderite from the latter locality as well as that from Hebron, contains scarcely any fluorine, its place being taken by hydroxyl, and the author proposes for it the name hydro-herderite. As the Stoneham herderite contains hydroxyl and fluorine in the proportions of 3 : 2, the one apparently replacing the other isomorphically, the name hydro-fluor-herderite is proposed for such intermediate varieties between theoretical fluor-herderite and hydro-herderite. In the crystallographic study the fact is brought out that the mineral is monoclinic instead of orthorhombic as has been supposed. This is proven not alone on Paris specimens but on specimens from the other localities, which were reexamined for this purpose. The crystals, however, approach closely to the orthorhombic system, the hydro- fluor-herderite being more nearly orthorhombic than the hydo-herderite, the substitution of fluorine for hydroxyl tending to increase the crystallographical axial angle and to shorten the clino-diagonal. It likewise diminishes the mean index of refraction and the optical angle.

Composition and Related Physical Properties of Topaz.—Jannatsch and Locke[5] have shown that topaz contains water of constitution, from a chemical study of specimens from San Louis Potosi, Ilmen Mts., Schneckenstein, and Brazil. Penfield and Minor[6] have independently established the same fact by a larger number of analyses, and shown how this greatly simplifies the formula of the mineral on

[4]Am. Jour. Sci., (3) xlvii, pp. 329-339.
[5]Am. Jour. Sci., (3) xlvii, pp. 386-387.
[6]Ibidem, pp. 387-396.

the assumption that hydroxyl and fluorine are isomorphous. Their results show that whereas the ratio $SiO_2 : Al_2O_3 : F$ varies from 1 : 1 : 1.50 to 1 : 1 : 1.84, the ratio $SiO_2 : Al_2O_3 : (F.\ OH)$ is constant and 1 : 1 : 2, so the formula of topaz becomes $(Al\ [F.\ OH])_2\ SiO_4$ or $(Al\ [F.\ OH]_2)\ Al\ SiO_4$. Their study of the physical properties of the mineral establishes a definite relation between them and the per cents of fluorine and water present, clearly indicating the isomorphous character of the fluorine and hydroxyl. The hydro-topaz has the smaller optical angle and the smaller specific gravity. The same fact is brought out by the determined values for α, β, and γ, and by exact measurements of interfacial angles. The optical anomalies of some Brazilian crystals are explained by zonal growth of topazes of different composition.

Composition of Chondrodite, Humite, and Clinohumite.—Penfield and Howe[7] have undertaken the study of the composition of the members of the humite group with the result not only of bringing order out of chaos, but also of establishing the fact that chondrodite, humite, and clinohumite constitute an homologous series both in a chemical and in a crystallographical sense. Sjögren has assumed that fluorine and hydroxyl are isomorphous, and derived new formulas for the members of this series, but as the authors point out the older analyses which Sjögren utilized are low as regards water, and Sjögren neglected to take into account the replacement of magnesia by ferrous iron and the consequent lowering of the silica percentage. The formulas derived by the authors, reckoning ferrous iron as magnesia, are as follows:

Chondrodite	$Mg_3\ (Mg\ [F.\ OH])_2\ (SiO_4)_2$
Humite	$Mg_5\ (Mg\ [F.\ OH])_2\ (SiO_4)_3$
Clinohumite	$Mg_7\ (Mg\ [F.\ OH])_2\ (SiO_4)_4$

The common difference of this homologous series is a molecule of chrysolite, $Mg_2\ SiO_4$. As shown by Sacchi and vom Rath, if the 'c_0' axis of crystals of chondrodite be divided by 5, that of humite by 7, and that of clinohumite by 9, the axial ratios of the three minerals become practically identical. Now these divisors, 5, 7, and 9, are the same as the number of magnesia atoms in the formulas of the corresponding minerals. A most interesting relation is thus brought out connecting the crystal forms and chemical compositions of the members of this group. The authors think it probable that other members of this series will be discovered, such as a mineral of the composition $Mg\ (Mg\ [F.\ OH])$,

[7] Am. Jour. Sci., (3) xlvii, pp. 188–206.

SiO_4. This compound should have either orthorhombic or monoclinic symmetry, with β equal to 90° and an axial ratio a : b : c=1.086 : 1 : 1.887.

Leucite from New Jersey.—Kemp[8] argues for the presence of partially decomposed leucites in a dyke rock at Rudeville, Sussex Co., N. J., from a micro-chemical test indicating the presence of potassium, and from remains of leucite twinning, in spheroids now largely made up of analcite, calcite, feldspar, and other supposed secondary products.

Variscite from Utah.—Packard[9] gives an analysis of a specimen of compact or cryptocrystalline variscite from a quartz vein near Lewiston, Utah. The analysis is as follows:

H_2O 22.95 P_2O_5 44.40 Al_2O_3 (By difference) 32.65.

Utilization of Auerbach Calcite for Nicols.—An attempt has been made[10] to utilize the clear calcite from Auerbach on the Bergstrasse, Germany, for Nicol's prisms. Four ordinary Nicols with inclined end faces were prepared by Schmidt & Haensch of Berlin, and although these are equal to the medium quality Nicols prepared from Iceland spar in the matter of extinction, they nevertheless contain inclusions, air bubbles, etc., which are visible even to the naked eye. Dr. Hoffman, the owner of the Auerbach quarries, still hopes to secure material pure enough to take the place of Iceland spar. The material already tested will suffice for technical purposes.

Crystallization of Willemite.—Willemite has been supposed to have rhombohedral tetartohedral symmetry from the similarity of its rhombohedral angles to those of phenacite. Penfield[11] studies crystals from the Merritt Mine, N. M., Sedalia Mine, Salida, Col., and Franklin, N. J. In the specimens from the first and last mentioned localities, rhombohedrons of the second and third orders were observed and measured, showing that the system is what has been supposed. On the crystals from the Merritt Mine the second and third order rhombohedrons are $\frac{\frac{2}{3}P2}{4}\frac{1}{r}$ and $\frac{\frac{3}{5}P\frac{3}{2}}{4}\frac{r}{1}$ respectively. One of the types from the Franklin Mines is terminated by a third order rhombohedron $\frac{3P\frac{3}{2}}{4}\frac{1}{r}$ alone, thus resembling the phenacite crystals from Mte. Antero, Col.

[8]Am. Jour. Sci., (3) xlvii, pp. 339–340.

[9]Am. Jour. Sci., (3) xlvii, pp. 297–298.

[10]Zeitschrift für Instrumentenkunde, 14te Jahrgang (1894), p. 54.

[11]Am. Jour. Sci., (3), xlvii, pp. 305–309.

The author shows that the cleavage of willemite is like that of troostite, indistinct cleavages parallel to both the base and prism being made out in willemite.

Composition of Staurolite and Arrangement of its Inclusions.—Exceptionally pure material for analysis was obtained by Penfield and Pratt[12] from St. Gothard, Switz., Windham, Me., Lisbon, N. H., and near Burnsville, N. C. A powder of uniform specific gravity was obtained in each case by the use of fused silver nitrate as a separating fluid in a specially constructed apparatus, the heavier and lighter portions of the powder being in this way removed. Reckoning MnO and MgO as FeO, and Fe_2O_3 as Al_2O_3, the four specimens yield results that agree well and indicate clearly that staurolite has the empirical formula H Al_5 Fe Si_2O_{13} as already suggested by Groth. The silica alone does not agree closely with this formula, being in every case about one per cent too high, and the authors think that this is due to the presence of inclusions of quartz too minute to be separated from the powder. Carbonaceous inclusions are in the staurolite from Lisbon, N. H., arranged in the same manner as in chiastolite crystals. The explanation of the authors is that the crystals of staurolite in growing in a solid rock, find it difficult to exclude foreign substances, the tendency to include them being greatest at the crystal edge and greatest where the interfacial angle is largest.

Determination of Quartz and the Feldspars in thin Section.—Sometime since Becke described a method of distinguishing quartz from feldspar by treatment with hydrochloric acid and subsequently tinting. He now[13] applies the same method to distinguish orthoclase from plagioclase and to determine the particular plagioclase species. Orthoclase is less affected by acid than plagioclase, and the soda rich plagioclases are less affected than the lime rich species. In rocks containing quartz, orthoclase and plagioclase, the slide is etched until by tinting the plagioclase shows an intense color. The orthoclase will then be faintly tinted and the quartz entirely unaffected.

Continuing his study Becke[14] has devised methods for the same determinations based on differences of refractive index. The first method consists in the examination of a perpendicular contact plane between

[12]Am. Jour. Sci., (3), xlvii, pp. 81-89.

[13]Tscherm. min. u. petrog. Mitth., xii, Heft 3, p. 2 (Notizen).

[14]Sitzungsber. d. k. Akad. d. Wissensch. i. Wien, Math. Naturw. Classe, Bd. II, Abth. I, pp. 358–376, July, 1893.

the two minerals with a cone of illumination of small angle. When properly focused, this contact appears as a sharp line. On raising the tube of the instrument, the focus is disturbed and a light band appears on the side of the contact toward the more refractive mineral, which band widens and finally fades out as the tube is raised higher. If, on the other hand, the tube be lowered, the same phenomena appear on the other side of the contact. The best results are obtained with the use of high powers and with a cone of illumination of small angle. Becke recommends the use of the *Irisblende* furnished with the newer instruments of Fuess. I have obtained good results with a small Voigt and Hochgesang instrument by removing the weak convex lens which covers the polarizer. Becke's *Schlierenmethode* makes use of inclined illumination, which is obtained with the *Irisblende* or with Abbe's *Beleuchtungsapparat.* With inclined illumination, that side of a section of strongly refracting mineral toward the direction from which the light comes, shows a light band against the less strongly refracting mineral surrounding it, while the opposite side shows a dark band. The author states that this method suffices to determine orthoclase, quartz, and a plagioclase when they are present together in a holocrystalline rock, but suggests that it be supplemented by the *Färbung* method. The method of determining the species of plagioclase depends on the comparison of the double refraction of the feldspar with that of quartz sections. By making per cents of *An* the abscissæ, and indices of refraction the ordinates, curves are obtained for α, β and γ within the feldspar series. These curves are intersected by the horizontal curves of ω and ε in quartz. If now α' and γ' be the less and the greater values respectively of the refraction for the two principal directions in any section of plagioclase, α' being between α and β and γ' between β and γ, the curves obtained indicate the following relations:

	Parallel Position		Crossed Position		Composition.
I	$\omega > \varepsilon'$	$\varepsilon > \gamma'$	$\omega > \gamma'$	$\varepsilon > \varepsilon'$	Ab —Ab_3 An_1
II	$\omega > \varepsilon'$	$\varepsilon > \gamma'$	$\omega = \gamma'$	$\varepsilon > \varepsilon'$	Ab_3 An_1—Ab_3An_1
III	$\omega = \varepsilon'$	$\varepsilon > \gamma'$	$\omega < \gamma'$	$\varepsilon > \varepsilon'$	Ab_3 An_1—Ab_2An_1
IV	$\omega < \varepsilon'$	$\varepsilon = \gamma'$	$\omega < \gamma'$	$\varepsilon > \varepsilon'$	Ab_2 An—Ab_3 An_2
V	$\omega < \varepsilon'$	$\varepsilon < \gamma'$	$\omega < \gamma'$	$\varepsilon = \varepsilon'$	Ab_3 An_2—Ab An_1
VI	$\omega < \varepsilon'$	$\varepsilon < \gamma$	$\omega < \gamma'$	$\varepsilon < \varepsilon'$	Ab_1 An_1—An_1

It is seen that these subdivisions of the plagioclases correspond in a general way to the earlier one of Tschermak, I being albite, II and III oligoclase, IV and V andesine, while VI includes labradorite, bytounite and anorthite. As Tschermak's later and more equable subdivi-

sion of the series has not been generally accepted, Becke thinks the harmony between his natural table and the older scheme of Tschermak a reason for retaining the original classification. The practical method of utilizing the results in his table, consists in finding contiguous sections of quartz and plagioclase which extinguish nearly parallel to one another. By means of the quartz wedge it is then determined whether the double refraction of these sections is of the same or of opposite sense. If the former, they are said to have parallel position and will indicate some of the relations of the first column of the table, and, if the latter, they have crossed position and their relations will correspond to something in the second column of the table. The quartz section always yields ω and a value varying but little from ε.

This method applies only to holocrystalline rocks which contain quartz, but it is a discovery of much importance which will doubtless be of much service in the study of the crystalline schists. The author has applied the method to the determination of the feldspar in many rocks of the Rosenbusch collection of B. Stürz, and printed his list of determinations. An excellent photogram also accompanies the paper.

Fluid Enclosures in Sicilian Gypsum.—The Cianciana gypsum contains cavities filled with liquid, some of which are 3 cm. in extent. Sjögren[15] has analyzed the liquid with the following results:

K_2O	Na_2O	CaO	MgO	Cl	SO_3	Total	O deducted for Cl_2	Cor. Total
2.1	40.9	4.1	3.9	44.9	14.1	110.0	10.1	99.9

Corresponding to

K_2SO_4	Na_2SO_4	$CaSO_4$	NaCl	$MgCl_2$	Total
3.7	11.4	9.7	66.2	9.0	100.0

The saline constituents were 4.023 per cent of the solution. This fluid is a fossil water of Miocene age, and differs from ocean water chiefly by containing a greater percentage of sulphates. It agrees fairly well with the water of some sulphur springs. The author thinks that the quantity of sulphates present in the water of the enclosure shows that the gypsum and sulphur cannot have been derived from a lagoon of sea water in which organic matters have reduced sulphur from the contained sulphates. Whether they are the product of sulphur springs or of emanations of H_2S in a lagoon of sea water in which sulphur has been deposited and sulphates formed by action of SO_3 on marls, the author is unable to determine.

[15]Bull. Geol. Inst. Upsala, I, (1893), No. 2, pp. 1–7.

New Sulphostannate from Bolivia.—In 1893 Penfield described a new isometric germanium mineral from Bolivia, which had the formula $Ag_8 Ge S_6$, and which he named canfieldite. This he showed to be identical chemically with Winkler's Freiberg mineral argyrodite, which that chemist had given the formula $Ag_6 Ge S_5$ and which Weisbach had considered monoclinic. Weisbach has since found that his earlier determination of the symmetry was incorrect, it being isometric tetrahedral and identical with the Bolivian mineral which should hence bear the name argyrodite. Penfield now transfers the name canfieldite[16] to a new sulphostannate of silver from La Paz, Bolivia, having isometric symmetry. A part of the tin is replaced by Germanium. The formula of the mineral is $Ag_8 (Sn\ Ge) S_6$, argyrodite being $Ag_8 Ge S_6$. The two minerals have similar physical properties, and are evidently isomorphous.

Allanite from Franklin Furnace.—Eakle[17] has made a crystallographical study of the allanite from the Trotter Mine, Franklin Furnace, N. J. The crystals occur in a granite dike associated with zinc ores. They are variable in habit and exhibit in all fourteen forms, none of which are, however, new to the species. The same author describes the tourmalines[18] from Rudeville and Franklin Furnace.

Miscellaneous.—Model[19] has found molybdenite and molybdite in the serpentine of the Rothenkopf, Zillerthal—. Carnot[20] has made an examination of the composition of wavellite and turquoise. In four analyses of wavellite from Cork, Ireland; Clomnel, Ireland; "Chester, Etats unis" (probably from Pennsylvania); and Garland, Arkansas, the fluorine was found to be 1.90, 2.79, 2.09 and 1.81 per cents respectively. Carnot proposes for the mineral the formula $2 (P_2O_5\ Al_2O_3) + Al_2 (O_3F_6) + 13\ H_2O$, but in the light of the recent work of Penfield, it seems more probable that part at least of the water present, is water of constitution, and that the fluorine replaces hydroxyl and not oxygen. In two specimens of turquoise of mineral origin (from Persia and Nevada respectively) no fluorine was found. Two specimens of occidental turquoise (odontolite) yielded each over three per cent of fluorine. The entrance of fluorine into odontolite during its derivation from fossil teeth, the author was led to expect from his study of the composition of fossil bones of the different geological ages.

[16]Am. Jour. Sci., [3], xlvii, pp. 451–4.
[17]Trans. N. Y. Acad. Sci., xiii, p. 102; also Am. Jour. Sci., [3] xlvii, pp. 436–8.
[18]Am. Jour. Sci., [3], xlvii, p. 439.
[19]Tscherm. min. u. petrog. Mitth., xiii, p. 532.
[20]Comptes rendus. cxviii, pp. 995–8.

GEOLOGY AND PALEONTOLOGY.

Origin of the Trilobites.—A study of the appendages of Trilobites leads Dr. Walcott to views confirmatory of those of Bernard in regard to the origin of the Trilobites. Dr. Walcott considers the modern Crustacea as "descendants of the Phyllopod branch, and the Trilobita form a distinct branch." (Geol. Mag., May, 1894).

Bernard's lastest communication on the subject, is to the effect that the great variability in the number of segments shown by Trilobites, the formation of the head by the gradual incorporation of trunk segments, the bending round ventrally of the first segment, the "wandering" of the eyes, the existence and modification of the "dorsal organ," and especially the character of the limbs, all serve to connect the Trilobites with *Apus*. That *Apus* lies low in the direct line from the original annelidan ancestor towards the modern Crustacea, and the Trilobites probably branched off laterally from this line, anterior to the primitive *Apus*, as forms specialized for creeping, with the protection of a hard imbricated carapace. This carapace resulted from the repetition on trunk segments of the pleurae of the head segments, which together form the head shield. (Proceeds. London Geol. Soc., March, 1894).

Some New Red Horizons.—A survey of Montgomery and Bucks Counties in Pennsylvania, has shown that the New Red in the former county is 27,000 feet thick. This unexpected result harmonizes with the recorded facts in other States. A study of this region has been made by Dr. B. Smith Lyman with the view of a better understanding of the relative geological position of the different horizons from which fossils have been reported in the "so-called American New Red" of the eastern part of the United States. Mr. Lyman recognizes in the Montgomery series five distinct horizons which he names and defines as follows, beginning with the oldest:

Shales mostly soft and red, but in small part dark gray or green, or blackish with beds of brown sandstone, and of gray sandstone and pebble rock, at Norristown and eastward, about 6,100 feet; Norristown Shales.

Shales, in great part hard, dark or greenish-gray and blackish, partly dark red, at the Gwynedd and Phœnixville tunnels, with traces of coal, about 3,500 feet; Gwynedd Shales.

Shales, mostly soft and red, at Lansdale and near it, about 4,700 feet; Lansdale Shales.

Shales, in great part hard and green, partly blackish and dark red, with some small traces of coal at the Perkasie tunnel and near it, about 2,000 feet; Perkasie Shales.

Shales, mostly soft and red, at Pottstown and northeastward, about 10,700 feet; Pottstown Shales.

The author then, from fossil records, traces these horizons in other Atlantic border States. In Maryland he finds the Gwynedd and Lansdale Shales represented. In Virginia, while the total New Red thickness is not so great as in Pennsylvania, there seems to be all five divisions represented. The North Carolina fossils all appear to belong to the Gwynedd Shales. In New Jersey the divisions are traced quite across the State with the exception of a dozen miles north, south and west of Somerville where the indications are not quite certain. In this State it is noticeable that the thickness of the New Red diminishes toward the northeast, and the variation is due to the absence of the upper beds, The diminution extends into Connecticut in greater degree, and still more so in Massachusetts. Almost all of the fossils in these two States represent the Gwynedd Shales. A list of all the recorded New Red fossils, arranged by the author according to the different horizons, facilitates comparison.

Mr. Lyman concludes his valuable contribution to geological literature with the following remarks:

"It is not improbable that the Norristown Shales, with the great calamite near Doylestown, the apparent Lepidodendron at Newark and Belleville, and the Palaeophycus at Portland, may after all prove to be at least as old as the Permian. It seems highly probable that the well ascertained great thickness of 27,000 feet in Montgomery County should represent more than one limited paleontological period, and not only that it should include the Permian, but that the very extensive upper third of that space, hitherto almost devoid of reported fossils, should turn out to be much newer than the Triassic. Those upper beds have also shown here and there imperfect fossil traces, and as there are occasional beds of green shale among the predominant red ones, there is reason to hope that more abundant and perfect fossils may some day be found."

As for the trap, the author thinks it impossible to doubt that all the conformable trap sheets are overflows contemporaneous with the sedimentary beds, and not subsequent intrusions. (Proceeds. Amer. Philos. Soc., Vol. XXXIII, 1894).

The Gosau Beds in the Austrian Salzkammergut.—The extensive literature of the Gosau Beds is a proof of their importance from a geological point of view. Since 1832 this remarkable formation with its unique fauna has been under discussion among European geologists. In a paper published in the Quart. Journ. Geol. Soc., 1894, Mr. H. Kynaston brings together the results of previous investigation on the stratigraphy and paleontology of the Gosau Beds, and gives an account of his own observations made with reference to fixing their geological horizon. The beds are divided into an upper and lower group, the latter extremely fossiliferous, while the former is almost devoid of organic remains. On both stratigraphical and paleontological evidence, the author correlates the Lower Gosau Beds with the Turonian and Senonian of the south of France. These in turn represent the English Middle and Upper Chalks. The Upper Gosau Beds being non-fossiliferous, cannot be located definitely, but the probability is that they represent the Danian of other districts and are on the same horizon as the chalk of Maastricht and Aix-la-Chapelle.

Geology of the Rocky Mountains between the Saskatchewan and Athabasca Rivers.—During the summers of 1892 and 1893, some explorations were made in the Rockies between Howse Pass and the Athabasca Pass. This tract of mountains, including some of the grandest mountain scenery in North America, has been neglected by scientific observers, so that maps hitherto published represent it incorrectly. New lakes and rivers were discovered, heights of peaks determined, and paleontological collections made. The results of a geological reconnaisance of this region are summarized as follows by Professor A. P. Coleman:

"To sum up the geological features of the region examined, we may describe the southeastern portion, well displayed along the Brazean River, as consisting of a series of seven or more minor ranges, each striking northwest and southeast, and tilted 25°–45° toward the coast line of the Pacific. These blocks, consisting of thousands of feet of quartzite and conglomerate, often overlain by thousands of feet of Devonian limestones, appear to have been thrown into their present attitudes by a series of reversed faults, as described by McConnell in Bow Pass. The rare folds observed in this portion of the mountains represent, perhaps, the dying out of such faults. Though no Cretaceous rocks have been proved to overlie the Devonian strata, it is probable that the faulting which produced the mountains took place

since Cretaceous times, for the foothills of Laramie sandstones give evidence of parallel faulting and tilting.

"On approaching the watershed of the Rockies west and northwest of the region just referred to, the regularity of the structure largely disappears. The direction and amount of dip vary, folds are not uncommon, and the rocks become more or less micaceous and metamorphosed; slates and sericite schists underlie the quartzites and conglomerates, and fossiliferous beds were not observed. The apparent absence of eruptive or plutonic rock is a feature worthy of note in a region where faulting has taken place on so huge a scale.

"The evidence of the action of Dr. G. M. Dawson's Cordilleran ice mass is distinct; the time which has elapsed since the Ice Age has been comparatively short, and the innumerable glaciers of the region represent the shrinking remnants of the ice sheet."

American Tertiary Aphidae.—It would hardly seem that plant-lice with their gauzy wings and soft bodies could be preserved in rocks. Yet they are not infrequently found. In Europe they are reported from four localities as well as from the Baltic amber. They have even been found in Mesozoic rocks. In America, Florissant, Colorado, has yielded 107 specimens, and they have been found at Green River, Wyoming, and Quesnel, B. C. The American Tertiary Aphidae have been described and figured by Dr. Scudder, and he has recently compiled a list of the species known, presenting them in a way to render their study comparatively easy and their diversity apparent. In the introduction he states that but one immature plant-louse has been found fossil in America, all the others are winged and belong to 32 species, divided into fifteen genera, of which 11 fall into the Aphidinae, the remaining four, with only five of the thirty-two species, into the Schizoneurinae, which have but a single branch to the cubital vein.

A characteristic feature of the American Tertiary Aphidae is a peculiarity in the neuration which is found also in the only wing known from the Mesozoic rocks. This feature is the great length and slenderness of the stigmatic cell. As a rule also the wings are long and narrow and the legs exceedingly short. Mr. Scudder calls attention also to the extraordinary variation in the neuration of the wings, which is strikingly greater than among living forms. (Thirteenth Ann. Rept. Director U. S. Geol. Surv. for 1891–92).

The Restoration of the Antillean Continent.—The following paper was read before the Brooklyn meeting of the Geological Society

of America. It is a difficult subject of unusual interest, and it promises to be epoch making in the department of dynamical and recent geology. Two previous papers by myself have been published by the Society upon topics leading up to the present investigations, which take into consideration the characteristices of the valleys both of the southern mountains and the coastal plains, and show how the valleys are directly due to atmospheric erosion. All of the land valleys become miles in width in their lower reaches, where they are buried by recent accumulations of sand, etc., to considerable depths. Off the coast there are broad submerged plateaus or terraces marking the pauses in the changes of sea level. Across these plateaus are numerous drowned *canons* or fjords shown to reach to very great depths. From their resemblance to the land valleys, they are regarded as of atmospheric or erosion origin, After passing the limits of the sands shifted by the coastal currents and filling the valleys, it may be said that every great valley has its fjord-like continuation through the submerged margin of the continental mass, even to depths of 10,000 or 12,000 ft. or more. From the natural inference that these valleys were formed above sea level, it would appear that the land had stood as high as the fjords are deep. But this statement is modified, for the movements have been in unequal undulations, the amount of which can often be calculated, and thereby the extreme depth has been reduced so that it seems that the former elevations of the West Indian region and adjacent parts of the continent may not have stood more than from 8,000 to 12,000 feet higher than now, according to the locality. The undulations of the earth's crust have been exaggerated by mountain folds in places, but in the great majority of the drowned valleys, such has not obtained for their direction is not parallel to the mountain ridges, but across that of the continental mass. Consequently there is no escape from the conclusion that the late continental elevation is measureable, but the movement has proved to be vastly greater than had hitherto been supposed, enough to change the whole physical geography of the region, the climate and the conditions of life. During the epochs of elevation, the Mexican Gulf and the Caribbean Sea were dry plains which extended to and were drained into the Pacific Ocean. The Antillean Islands formed a plateau-bridge connecting the two Americas.

At the close of the Miocene period, the Antillean and Central American lands were represented by only small islands. Then succeeded the Pliocene period during the earlier and mid portion of which the great elevation occurred. This was succeeded by the subsidence about the close of the Pliocene period, long enough to allow the

accumulation of the Matanzas limestones (of Spencer), but in amount not exceeding a depression of from 100 to 1300 feet below the present level. There was a late Miocene mammalian fauna on the continent, but it did not extend into the Pliocene period, for no mammals of that date are known east of the Mississippi River. As the fauna flourished when the continent was at about the same altitude as now, the great change in elevation, causing the subtropical climate to become subarctic, may have been sufficient reason for the restriction of the earlier life, whose descendants would have been extinguished by the drowning of the now insular region and 250,000 square miles of the continent. Again the continent rose to an altitude about as great as that of the Pliocene days, when it suffered an enormous erosion. During this earlier portion of the Pleistocene period, there was a rich mammalian fauna of horses, elephants, tapirs, camels, etc., but these were exterminated by the succeeding depression which carried down the Antillean lands to the proportions of small insular masses, and reduced the plains of the northern continent by 150,000 square miles. Since that time there have been reëlevations and minor undulations, but no connection between the islands and the continent, so that the modern types of mammals have been unable to reach the West Indies.

The changes which have occurred in the West Indies and those of the adjacent portion of the continent have been nearly identical, but the movements in the Antillies appear to have been somewhat more energetic, and the geographical evolution of the continent is best studied from the West Indian phenomena, but neither region is complete without the other. The general problem could not have been elucidated until the investigations which I have made upon the fjords.

The connection of the Antillean waters with the Atlantic and the separation from the Pacific Ocean should be noticed. There was free communication between the two oceans about the close of the Miocene period. The Pliocene union of the two continents separated the two oceans, although there may have been an enclosed sea between Cuba and Jamaica. With the subsidence of the land at the close of the Pliocene period, there was only a narrow and shallow communication between the Antillean waters and the Pacific, but the connection with the Atlantic was more complete than now. These connections were again closed during the Plistocene elevation. With the depression of mid-Plistocene days, the Atlantic was again admitted to the Mediterranean Seas, and it is also probable that there were two or three shallow passages leading to the Pacific. During the later Plistocene and modern days there have been no change of level which have effected

the oceanic connection. The changes of level have been of two characters; (*a*) the epeirogenic or continent-making movements, which produce broad but gentle undulations, depressing basins or raising up barriers, but not distorting the topographic features so as to render them unrecognizable, and (*b*) orogenic or mountain-making movements, which are most energetic over limited zones, and produce disfiguring barriers. Whilst the Antillean region was sinking with gentle undulations, the Central American mass was slowly rising, but it was farther deformed by the great mountain making movements and the late volcanic accumulations, which have completed the separation of the Antillean Seas and the Pacific Ocean.

The phenomena are extremely suggestive, and from the evidence brought out it appears that many problems of physical geology will need readjustment in the light of the changed continental condition, ocean currents, climate and distribution of life. The subject is important as a contribution to the structure of land features in their interpretation of geological history.

J. W. SPENCER.

The Drainage of the Great Lakes into the Mississippi River by way of Chicago.[1]—I now add another short chapter to the history of the Great Lakes. The highest beach south of Chicago is 45 feet above the lake and there are several beaches just above the present lake level. The divide between the lake and the Mississippi drainage is only eight feet above the lake, and this at a point 25 miles southwest of Chicago. The succession of beaches at the head of the lake has led to confusion, as there is an enormous lapse of time between, for the highest amongst the oldest shore lines of the later region from its level the lake shrinks to a plain 300 feet below, whilst the waters were being drained by way of the Huron Basin and the Ottawa River. Afterwards terrestrial deformation raised the northeastern river of the basins and turned the Huron waters into the Erie and Michigan basins, and for a time overflowed the Chicago divide, which became drained about 1500 years ago by the recession of Niagara Falls through Johnson Ridge. With the terrestrial deformation continuing as in the past, it is estimated that the drainage of all the upper lakes may be turned into the Mississippi in about 5000 or 6000 years.

J. W. SPENCER.

Geological News. GENERAL.—Professor T. C. Bonney calls attention to the possibility that a rock of igneous origin can be so

[1]Abstract of paper read before the American Assoc. Adv. Science.

changed by pressure and indirect consequences as to be readily mistaken for a compact and not very much altered sediment. He instances particular cases of schistose green rocks in the Alps which upon examination prove to be the result of crushing without shearing. The author suggests that modified igneous rocks may form a large part of the *Grüne Shiefer* of the Swiss geologists. (Quart. Journ. Geol. Soc., May, 1894).

ARCHEAN.—Evidence is presented by Mr. J. E. Spurr for correlating the Thompson slates, which occupy an extensive area in eastern Minnesota, with the Keewatin of the Mesabi Range rather than with the Animikie of that district. If the suggested correlation is correct, it will follow that the erosion interval between the Animikie and the Keweenawan was very great. (Am. Journ. Sci., Aug., 1894).

CENOZOIC.—M. L. Cayeux calls attention to the presence in the precambrian formations of Bretagne of Foraminifera of a relatively complex form associated with a large number of Radiolaria. The rocks which contain these organisms are quartzites and phtanites interstratified with the precambrians of Saint Lo. (Revue Scientif., 1894).

The discovery of certain fossil corals in Shasta and Siskiyou Counties in California, demonstrates the undoubted presence of middle Devonian deposits in that region. Notes on these fossils are given by Mr. Schuchert in Am. Journ. Sci., June, 1894, together with some correlations of the beds in which they were found with those of other regions. The Shasta County fossils are believed to indicate the Corniferous terrane as developed in New York, Kentucky, Michigan and Ontario. Those of Siskiyou County are of younger age, and agree in a few cases specifically with those of the Devonian of the White Pine Mining District in Nevada.

Mr. A. Smith Woodward records four new fossil fishes from the Karoo Formation. The descriptions are accompanied by plates showing the specimens natural size. Three of the fossils are Palaeoniscidae and the fourth belongs either to that family or to the Platysomidae. (Ann. Mag. Nat. Hist., 1893).

Newberry's genus, Spiraxis, is represented in the Devonian of Belgium. M. Stainer in describing this curious spiral fossil agrees with Newberry in supposing it to be the remains of a species of alga, and gives it the name *Spiraxis interstrialis*. (Bull. Soc. Belge de Geol. Pal.

et Hydrol., 1894). Dr. Hollick, however, shows that the bodies thus described are the casts of the spiral intestine of Cladodont sharks. (New York Acad. Sciences.)

MESOZOIC.—According to M. Lechien, the invertebrate fossils found in the bed from which the famous Ichthyosaur of Arlon was taken, indicate a formation belonging to the middle Lias instead of lower, as was at first supposed. (Bull. Soc. Geol. Bruxelles, 1894).

CENOZOIC.—The old theory first advanced by Shaler in 1870, of the origin of drumlins by a destructive process, that is, a working over of morainic or other drift deposits, have been revived by Prof. R. S. Tarr. He brings forward facts to support it, and discusses three objections to it, but concludes on the whole that this theory forms a good working hypothesis, even if it is not accepted as the most probable theory. (Am. Geol., June, 1894).

Mr. Warren Upham offers, as an explanation of the Plistocene climatic changes, the epeirogenic theory of the Ice age thought out and formulated by Dana, Le Conte, Wright, Upham and Jamieson. He conceives the Ice age to have been essentially one and continuous, with important fluctuations. Soundings off the West African Coast record a submerged channel of the Congo extending eighty miles into the ocean to a depth of more than 6,000 feet. Another deep submarine valley having soundings of 2,700 feet is known on the African Coast 350 miles north of the equator, and there is a similar valley in the southern part of the Bay of Biscay. These remarkable valleys beneath the sea level indicate that probably the entire Atlantic side of the Eastern Continent has been greatly uplifted within late geologic time. (Geol. Mag., Aug., 1894).

In regard to the "Black Earth" of Russia, Dr. W. F. Hume suggests (1) the position of Loess has been determined by the manner and conditions of its origin, and (2) Black Earth is merely a special closing feature in the sequence of a long history of Loess, and it is merely that deposit rich in humus resulting from the decomposition through long ages, of generations of grasses and steppe plants. (Geol. Mag., Aug., 1894).

The Yellow Gravel of New Jersey is made the subject of special discussion in the report of Prof. Salisbury upon the surface geology of that State. After giving its distribution and its history as inferred

from its character and position, the author states that the study of this formation leads to the following conclusions:

(1) The original yellow gravel is Pre-plistocene. (2) The time of its deposition was followed by an epoch of elevation and extensive erosion of long duration. (3) Then came a period of depression during which the Columbia deposits were made, equivalent in age with the first glacial deposits. (4) Again an epoch of elevation and erosion, when the degradation and redistribution of the original formation went forward. (5) An epoch of slight depression. (6) Subsequent elevation to the extent of forty to sixty feet, followed by the present subsidence. (Ann. Rept. Geol. Surv. New Jersey for 1892).

ZOOLOGY.

Parthenogenesis among the Acari of Feathers.—In a communciation to the Entomological Society of France, Dr. Trouessart states that he has observed a parthogenetic manner of reproduction in the plumicolous Sarcoptidæ under such conditions as to preclude the possibility of mistake. In 1888 Dr. Trouessart described an Acarian, *Syringobia chelopus*, which is found in the tubes of the feathers of *Totanus calidris*, a bird of passage through France in the Spring and Fall. A study of the life history of this species has developed the following facts.

In the Spring little colonies of the Acarian are found in the tubes of the feathers of the migrating wader, evidently having wintered in those narrow quarters feeding on the pith of the feather. Their numbers are small rarely exceeding ten or twelve in each colony. The composition of the colonies is variable, but taking 25 or 30 of the principal feathers of the wing together there will be found the following eleven forms. (1) Eggs with a shell; (2) Naked eggs; (3) Normal larvæ; (4) Abnormal larvæ; (5) Normal nymphs; (6) Abnormal nymphs; (6) Sexually developed females or secondary nymphs; (9) Abnormal females; (10) Normal males or *heteromorphs;* (11) Abnormal males or *homeomorphs.* All of the forms are not found together in the same feather. The normal form and the abnormal form (which I have called *syringobia*) live in separate feathers, and the naked egg belongs to the latter form. The males in the abnormal series are very rare, only one or two for one hundred females in that series; while in the normal series the proportion is one male to three females. Neither normal males or eggs with a shell are found with the syringobial females. These lay naked eggs covered only with the thin hyaline membrane which forms the inner covering of the shelled eggs.

In a general way the syringobial form, is distinguished from the normal by its large cheliceres and by the thin, transparent skin over the posterior part of the body. The syringobial female is larger and more elongate than the normal type.

The skin left after the final moult, which transforms the syringobial nymph into an adult female, is totally wanting in the post-anal opening which corresponds to the copulatory pouch and which is perfectly plain in the secondary normal nymph or sexually developed female.

The life-history as traced by Dr. Trouessart proceeds as follows:

At the time of the autumn moult which preceeds the departure of the birds for the warm countries a certain number of young larvæ or nymphs of *Syringobia* penetrate the tube of the feather through the *ombilic supérieur*. Three or four are thus installed in each feather. If there is one or more males in the colony the development is normal, and the fertilized females lay shelled eggs. On the contrary, if there are no males, the female nymphs having attained the age of the secondary nymph, instead of being transformed into normal females continue growing until the body is nearly double the size of the normal secondary females, assuming more and more the characters of the syringobial form; then they undergo a final moult and are transformed into parthenogenic females laying eggs without shells. From these eggs are developed larvæ, which reproduce the parthenogenetic form during the migration of the bird. At the end of the journey, either immediately or during the stay in the warm region, the young issue from the two series (the normal egg and the parthenogenic egg), leave the interior of the feather and make their home on the plumage. In fact, Syringobia is found on the plumage of birds killed in the warm countries, but they are found in the feather only during migration.

Parthenogenesis, in this case, according to Dr. Trouessart is the result of the segregation of individuals and the death of males. It is probable that this phenomenon is more frequent in this group than has been hitherto supposed. (Bull. Soc. Entomol. Paris, 1894.)

Trionyches in the Delaware drainage.—Turtles of this family have been supposed to be absent from the Delaware drainage, but the two following instances show that this view is no longer tenable. In the latter part of August a specimen of the "soft shelled turtle" was captured in the Paulins Kill at Hainesburg, Warren, Co., N. J. and sent to the museum of the Wagner Institute by Mr. E. B. Allen. The mounted specimen measures as follows: Total length 18 inches. Length of carapace 12 inches, width 9 inches. Length of plastron 8 inches. The tough integument has shrunken somewhat and its true measurements exceeds these by about one inch. Color a dark brown, with black spots, many of these ocellate, under surface white, feet dark yellow irregularly marked with black.—CHAS. W. JOHNSON.

NOTE ON THE ABOVE—Two individual Trionychidæ were captured in a pond near Woodbury, N. J. about a year ago, and are now living in captivity. I have not seen them, but there is no doubt as to the fact.—E. D. COPE.

The Femoral Gland of Ornithorhynchus and Its Secretions.—At the July meeting of the Linnean Soc. N. S. W. a paper on the secretions of the femoral gland of the Ornithorhynchus was presented by C. J. Martin and F. Fidswell. The paper contained also notes of an experimental enquiry concerning the toxic action of these secretions.

The gland is described as belonging to the compound racemous variety with large alveoli possessing a wide lumen, and somewhat recalling the appearance of a mammary gland. The alveoli communicate with ducts which eventually join at the hilus of the gland to form the duct leading to the spur.

The gland is surrounded by a capsule of fibrous tissue, exterior to which is a thin layer of smooth muscle fibres. A marked difference in the minute structure of the gland was noted in animals killed in June and those in April respectively, the former showing the appearance characteristic of an actively secreting gland, whereas the latter suggested that of a mammary gland when it had undergone retrogressive metamorphosis.

Examination of the poison showed it to consist principally of albuminous bodies, and the introduction of these into rabbits produced very marked poisonous results. When injected under the skin, local swelling and general depression and rise of temperature followed, but in three days the animal was well again. When the poison was introduced directly into the vascular system, small quantities ($\frac{1}{3}$ grain) caused death in under half an hour. Larger doses so introduced produced almost immediate death, by producing nearly universal clotting of the blood whilst travelling in the blood vessels. Such clotting naturally soon put an end to all circulation.

In summing up, the authors compare the action of Ornithorhynchus poison with that of the venous of Australian snakes, supposing the latter to be diluted 5000 times. (Nature, Sept,, 1894.)

Change of Color in the Northern Hare.—From the study of 75 specimens of *Lepus americanus* collected for the express purpose of investigating the seasonal change of color, Mr. J. A. Allen arrives at the following conclusions:

(1) The change of color, both in autumn and in the spring, is due to change of pelage, and not to a change in the hair itself.

(2) The change is gradual, occupying many weeks.

(3) The method of change, as regards the parts first affected is the reverse in spring in the order characterizing the autumnal change.

(4) In the early part of spring, after the white overhair has been shed, the pelage consists of the heavy coat of soft winter underfur. This gradually disappears as the summer coat thickens.

(5) In spring the moult occurs quite as early and proceeds just as rapidly in the females as in the males, and the moult is practically completed before the young are born.

These conclusions differ widely from views hitherto entertained by both scientific and non-scientific writers. (Bull. Amer. Mus. Nat. Hist., 1894.)

Zoological News. MOLLUSCA.—The characters in the shell of *Nautilus pompilius*, described as sexual by J. Van der Hoeven, are believed by Messrs. Bather and Buckman to be due to age rather than to sex. In that case a strong point in favor of sexual dimorphism in Ammonite shells has lost its value. (Nat. Sci., Vol. VI, 1894.)

In a discussion of the geographic and hypsometic distribution of North American Viviparidæ, Mr. E. Call recognizes four genera, viz., Tulotoma, with two species; Lioplax, with two species; Vivipara, with four species; and Campeloma, with nine species. This arrangement is based upon the examination of several thousand specimens. Of these species, *Campeloma decisum* Say has the widest range and *Vivipara troostiana* the most restricted. The latter is abundant in a small stream near Murfreesboro, Tennessee, and there is no record of its being found elsewhere. Vertically, the most of the species lie between 100 and 700 feet altitude. Here again *Campeloma decisum* has the greatest range. (Am. Jur. Sci., Vol. XLVIII, 1894.)

CRUSTACEA.—A new species of Tanais (*T. robustus*) is described by Mr. H. F. Moore. It inhabits minute tubes in the crevices between the scales of the carapace of *Thalassochelys caretta*. (Proceeds. Phila. Acad. Sci., 1894).

A blind cray-fish from Florida is described by Dr. Lönnberg under the name *Cambarus acherontis*. The specimens we obtained from a subterranean rivulet struck about 30 feet below the surface of the ground in Orange County. They represent the fourth species of Cambarus found in the United States. (Zool. Anz., 1894.)

VERTEBRATA.—Dr. Boulenger describes 13 new species of fresh-water fishes from Borneo. They are referred to 9 genera of which one, Nematabramis, is new. Three species, *Nemachilus olivaceus*, *N. saravacensis* and an *Acanthophthalmus* are of special interest as the first Cobitines described from Borneo. (Ann. Mag. Nat. Hist., Vol. XIII, 1894.)

Prof. E. D. Cope has recently published a paper on Reptiles and Batrachians from Costa Rica in which he enumerates fifteen new species, distributed as follows; 1 Urodela, 4 Salientia, 3 Lacertilia, and 7 Ophidia. Among them are two new genera; Levirana, identical with Ranula, but without vomerine teeth, and Pogonaspis, more nearly allied to Tantilla than to any other genus, but differs from it in the large single genial plate. (Proceeds., Phila. Acad., 1894.)

A preliminary list of the Reptiles and Batrachians of the Island of Trinidad prepared by Messrs. Mole and Urich shows a total of 76 species distributed as follows: Tortoises 6; Lizards 25; Snakes 33, Batrachians 12. Of these species 21 are recorded for the first time from the Island and two are new to science. The latter are described by Boettger under the names *Sphærodactylus molei* and *Hylodes urichii* (Journ. Trinidad Field Naturl. Club.)

A small collection of reptiles and fishes from Lake Tanganyika examined by Dr. Gunther includes a new genus of snakes, Glypholycus, of which one species only is described, *G. bicolor*. Two new species of Mastacembelus which appear to connect the Asiatic species with the West African, and three species referred to Chromis. (Proceeds. London Zool. Soc., Nov., 1893.)

According to Dr. Shufeldt the fibula in many birds is complete, normally reaching the ankle-joint. He cites as examples in the Steganopodes, the Snake-bird *Plotus anhinga*, *Phalacrocorax bicristatus* (almost complete), *Sula piscator*, *S. cyanops*, *S. bassana*, *S. gossii* and *Fregata aquila*. Judging from the literature upon the subject, this fact concerning avian anatomy is not generally known. (The Ibis, July, 1894.)

Among the mammals of Baltistan and the Vale of Kashmir, presented to the U. S. Natl. Mus. by Dr. W. L. Abbott, are three species of Arvicola, *A. fertilis*, *A. montosa* and *A. albicanda*, which are new, and also a new geographical race of *Mus arianus*. *Sminthus concolor* in this collection extends the range of that species a thousand miles. (True in Proceeds. U. S. Natl. Mus. Vol. XVII, 1894.)

In his studies of North American Mammals Mr. F. W. True finds it necessary to place Brewer's mole in a new genus, Parascalops. In the same paper are given diagnoses of an undescribed race of Albert's squirrel, *S. aberti concolor*, a new lemming, *Myodes nigripes*, and a lemming-like mouse, representing a new genus, *Mictomys innuitus*. (Proceeds. U. S. Natl. Mus., 1894.)

ENTOMOLOGY.[1]

North Ameridan Ceutophili.—This interesting group of wingless locustarians has been monngraphed in a very satisfactory manner by Mr. S. H. Scudder.[1] "With the exception of the genus Troglophilus Krauss, with two species from European caverns, and the genus Talitropis Bol., with a single species from New Zealand, placed respectively at one and the other end of the series, they are known only from America; and with the further exception of Heteromallus Brunner, with two species from Chili, they are all peculiar to the United States and Northern Mexico. Here they include six genera and sixty-seven species, the genus Ceutophilus alone containing above fifty species. The larger proportion of them, if not all (excepting *Udeopsylla nigra*) frequent dark places, such as burrows, pits, caverns, wells, hollow trees, and especially the crevices beneath fallen logs." Thirty-eight new species are characterized in the present paper, in which the treatment, except for the absence of illustrations, is all that could be desired.

The Plume Moths.—A study of the biological relations of the earlier stages of the plume months convinces J. W. Tutt[3] that these insects belong to two distinct families, the Pterophorina and the Alucitina. The latter (called Orneodinæ by Fernald and others) "belong to the Pyraloid section of the Obtectæ, the larva of which has a complete circle of hooks to the ventral prolegs, and the pupa of which is smooth and rounded, laterally solid, inner dissepiments flimsy. The free segments in both sexes are the fifth and sixth abdominal.

"The Pterophorina belong to the Incompletæ and have no affinities with Alucitina. Both groups have under the same or similar necessities developed plume wings and this is the only connection. The pupa is attached by a cremaster, less solid and rounded, appendages often partially free. Free segments may extend up to the third abdominal."

In emphasizing the necessity of biological studies in classification, Mr. Tutt quotes with approval, the recent dictum of W. H. Edwards: "There never will be a final authoritative revision of any genus of butterflies till the preparatory stages in every species of it are known."

[1] Edited by Clarence M. Weed, New Hampshire College, Durham, N. H.
[2] Proceedings Amer. Acad., VXXX, pp. 17–113.
[3] Ent. News, V, 209.

New Use for Bisulphide of Carbon.—Professor J. B Smith acting on the suggestion of Professor H. Garman finds by experiment that bisulphide of carbon can be used to advantage against aphides on plants above ground. By covering infested melon vines with a tub or other closed vessel, and allowing a drachm of bisulphide to evaporate in a shallow dish beneath it, the pests were killed at the end of one hour. The coverings were then removed.

Mimicry in Diptera.—Mr. C. J. Wainwright reports[4] interesting observations on mimicry of Diptera flying in England in early spring. Two species of the Syrphid genus Cheilosia so resembled bees of the genus Andrena as to make it very difficult to distinguish them. "They particularly resembled *Andrena fulva*, and we netted far more of the bee than of the Dipteron in our efforts to get the latter. The resemblance is very strong, color, size, and (to a considerable extent) shape being much the same; when at rest on a flower the Dipteron curls its body under a little as the bee does, and folds its wings over its back in the same manner."

There was also present a species of Echinomyia of the family Tachinidæ, which had a bee-like appearance, differing in this respect from other members of its genus. "It, however, resembled no species in particular; it bore a general resemblance to *Bombus muscorum* in size, shape and color, but it was not so hairy and did not fold its wings bee fashion."

In commenting on these observations Mr. Wainwright says: "There is very little doubt that in the spring, when insects are not very numerous, and when, therefore, we may reasonably infer that their enemies are unusually alert in discovering and capturing them, that it must be even more necessary than during the summer, for those insects which do appear, to be well protected in some way from their foes, and especially if they happen to be species which, through feeble reproductive powers or other similar causes, are limited in numbers to commence with. Now, the two Cheilosiae are distinctly species which are limited in numbers, in fact, they are somewhat rare species, and may be described as occurring singly; they are not robust species, in fact, rather the reverse, and, therefore, they are just such species one would expect to find protected by mimetic resemblances. In every way they may be said to present all requirements of an ordinary case of mimicry.

"The Echinomyia, however, does not present so ordinary a case. It is a wonderfully strong and robust species, belonging to a group of

[4]Ent. Monthly Magazine.

parasitic species, all of which are strong and robust, and ordinarily neither need nor possess any such protection as a mimetic resemblance. It is well protected on the body by strong hairs, answering, to some extent, the purpose of spines, and is very strong on the wing; it is very large, too, many specimens being 8 or 9 lines long. It, however, occurs at this time (March) when other insects are scarce, and it must be conspicuous and so tempt its foes, and although common on this particular occasion at Wyre Forest, I do not think it is usually a common species, at least, I never saw it before; altogether, although it does not answer the usual requirements of a mimetic species, yet there are obviously good reasons why a resemblance to the strong and usually unmolested Bombi would be an advantage to it. We accordingly find that it does possess some such resemblance, though imperfect, and it is just this imperfection which is its most interesting feature, and it is to some extent the reason for these notes.

"Many or all of the opponents of the theory of mimicry urge very strongly the difficult question, how does the resemblance arise? In early stages it can be of no use to its possessor. But here, I think, we have a case showing how mimicry may arise, and even the early stages be of use. The Tachinidæ do not, as a rule, resemble in the least degree any Hymenoptera, they are quite unlike bees. The Echinomyia are a genus of unusually large and well developed Tachinids, some of which (fera and ferax for example) are simply ordinary Tachinids in appearance, though unusually large, and quite unlike bees; they are summer species; Ursina, however, a spring species, though closely allied to these others by a comparatively slight alteration in color, a development rather than an alteration, and the increase of its hairs in number and size, at once and unexpectedly somewhat resembles *Bombus muscorum*, and almost certainly must derive some protection from even this superficial resemblance, at a time when food is being so eagerly sought by insect foes. It only needs a still further increase in hairiness, and to fold its wings over its body, and it would be an almost perfect mimic; and supposing its nearest allies to be lost, we should wonder how the early stages arose."

Description of a New Pelecinus from Tennessee.—The genus *Pelecinus* forms a peculiar family allied to the Proctotrupidæ, in the Antigynea, among the highest Aculeate hymenoptera. The costal vein in rare instances is not developed, showing a transition to the higher non-aculeate monotrocha or Hymenoptera minuta. The larval habits are unknown, although the imago has been observed issuing

from the ground and locust eggs are possibly its food. The discovery of a new species is therefore of interest.

The antennæ are fourteen-jointed in both sexes, those of the male longer. The mandibles, armed with a tooth near the apex within, and the labial palpi show no sexual difference. The maxillary palpi, long in the female, are not visible in the male. The middle and the hind tibiæ are two-spurred in both sexes; the hind tibiæ greatly swollen in the female, are no more swollen than the femora in the male. The first joint of the hind tarsi in both sexes is as short as the last joint.

The abdomen of the female is elongate, cylindric, six-jointed, with a seventh dorsal joint connate with the sixth; sting minute; the abdomen of the male is cup-shaped, likewise six-jointed; claspers directed forwards beneath. In the male abdomen the first segment is three times as long as all the rest combined, gradually enlarged towards the extremity; the third and fourth segments are longer above than beneath; the fifth and sixth segments are vertical, invisible from above.

PELECINUS BRUNNEIPES, n. sp.

Female.—Size of *dichrous*. Disc of propodeum behind punctoreticulate. An oblong brown cloud in the first submarginal cell behind the stigmal cloud. Legs piceous-brown; middle and fore tibiæ and tarsi clay-yellow. Tenth and apical half of ninth joints of atennæ whitish. The whole insect otherwise shiny black.—One specimen collected at Marysville by Prof. E. M. Aaron.

In *P. polycerator*, which is of larger size, the disc of propodeum behind is transversely arcuately rugose, the depressions punctate; there is no separate cloud in the wing; and the legs, except tarsi, are entirely black.

PELECINUS DICHROUS Klug.

Specimens of this South American species, kindly sent me by Prof. Carl Berg, of Buenos Ayres, show the disc of the propodeum behind transversely rugose in the female and longitudinally rugose in the male. The female has the ocellar tubercle, the clypeus, a spot above clypeus, a spot at base of mandibles, the thorax (especially above) red; the legs more or less brownish; the tenth joint and apex of ninth joint and base of eleventh joint of antennæ orange. The male has none of the red shown in the female and the atennæ are entirely black.

WM. HAMPTON PATTON.

Flight of Locusts.—Mr. C. B. Mitford gives an interesting account of what was, he says, a more marvellous sight than any he has ever

seen. The changed appearance of the "bush" at Freetown, Sierra Leone, on the 25th of November, 1893, led him to call the attention of a native, who told him that locusts were coming. In a short time huge black clouds appeared above the hills, and these first seen gave the idea that the whole of the sides of the hills, three miles off, were on fire; at 2.45 p. m. these supposed clouds reached Freetown and proved to be a continuous mass of locusts, which passed without intermission till 5.10 p. m. Myriads settled, but made no apparent difference in the size of the swarms. The whole town was covered with their excrement. At 9.45 a. m. the next day the stream began again, but not in such dense masses, and continued up to 1 p. m. The species has been found to be *Pachytylus migratoroides* originally described from Abyssinia.—*Journal Royal Microscopical Society.*

[b]Proc. Zool. Soc. Lond., 1894, p. 2.

PSYCHOLOGY.

The Habit of Amusement in the Lower Animals.—In some former papers which have already been published in this journal and elsewhere, I have shown that animals exceedingly low in the scale of animal life possess the five senses, sight, smell, taste, hearing, and touch, or senses akin to them; also that these animals evince a high degree of intelligence.[1] One would naturally expect to find in animals biologically so akin to man, some evidences of enjoyment other than the mere gratification of animal desires. This expectation or surmise is undoubtedly correct, and it is the purpose of this article to demonstrate this truth. We are all familiar with the pastimes of the higher animals such as the dog, the cat, the horse, the squirrel, the rabbit, the monkey, etc. We do not question the fact that these animals do amuse themselves in many a frolic and wild romp; they form a part and parcel of our lives, consequently their pastimes are not considered remarkable. I propose, however, to show that animals much lower in the scale of life—animals so low and so minute that it takes a very high-power lens to make them visible, likewise have their pastimes and amusements. Also, that many insects and even the slothful snail are not so busily engaged in the struggle for existence that they can not spare a few moments for play. In our researches in this field of animal intelligence we must not attribute the peculiar actions of the males in many species of animals when courting the females, to simple pastime, for they are the outward manifestations of sexual desire, and are not examples of psychical amusement. I have seen, in actinophorous rhizopods, certain actions, unconnected with sexual desire or the gratification of appetite, which lead me to believe that these minute microscopic organisms have their pastimes and moments of simple amusement. On several occasions while observing these creatures, I have seen them chasing one another around and around their minature sea. They seemed to be engaged in a game of tag. This actinophrys is not very agile, but when excited by its play, it seems to be an entirely different creature, so lively does it become. These actions were not

[1] North American Review: "The Senses in the Lower Animals."
American Naturalist: "Animal Intelligence."
Atlantic Monthly, Contrib. Club: "Animal Letisimulants."
Worthington's Magazine: "The Emotions in the Lower Animals."

those of strife, for first one and then another would act the pursuer and the pursued. There were, generally, four or five actinophryans in the game. One of the rotifers frequently acts as if engaged in play. On several occasions I have observed them perform a kind of dance, a *pas seul*, for each rotifer would be alone by itself. Their motions were up and down as if exercising with an invisible skipping-rope. They would keep up this play for several minutes and then resume feeding or quietly remain at rest. This rotifer goes through another performance which I also believe to be simply a pastime. Its tail is armed with a double hook or forceps. It attaches itself to a piece of alga or other substance by this forceps, and then moves its body up and down in the water for several minutes at a time. The snail (*H. pomatia*) likewise has its moments of relaxation and amusement. The following instance of play may be considered to be gallantry by some, but I do not believe that I am mistaken, however, when I consider it an example of animal pastime. Two snails approproached each other, and, when immediately opposite, began slowly to wave their heads from side to side. They then bowed slightly several times in courtly salutation. This performance they kept up for quite a while and then moved away in different directions. At no time did they come in contact, and careful observation failed to reveal any excitement in the genitalia. I have witnessed the embraces of snails, and the performance described above does not resemble in the slightest degree, the manouvres executed at such times by mating individuals.

Swarms of Diptera may be seen on any bright day dancing in the sunlight. Naturalists have heretofore considered this swarming to be a mating of the two sexes. This is not the case, however, in many instances. On numerous occasions, and at different seasons of the year, I have captured dozens of these insects in my net and have examined them microscopically. I found them all to be unimpregnated females; I have never yet discovered a male among them. In some of the Diptera the males emerge from the pupa state after the females; I therefore believe that the females await the presence of the males, and, while waiting, pass the time away in aerial gambols.

Forel, Lubbock, Kirby, Spence and other naturalists have declared that ants, on certain occasions, indulge in pastimes and amusements. Huber says that he saw a colony of *pratensis*, one fine day, "assembled on the surface of their nest, and behaving in a way that he could only explain as simulating festival sports or other games." On the 27th of last September, the males and females of a colony of *Lasius flavus* emerged from their nest; I saw these young kings and queens con-

gregate about the entrances of the nest and engage in playful antics until driven away by the workers. The workers would nip their legs with their mandibles until they were forced to fly in order to escape being bitten. On the 19th of this month (July) I saw several *Lasius niger* come out of their nest accompanied by a minute little beetle (*Claviger foveolatus*); the ants caressed and played with this little insect for some time, and then conducted it back into the nest. Many little animals are kept by ants simply as pets. Lubbock says of one of them, a species allied to *Podura*, and for which he proposes the name, *Beckia*. "It is an active, bustling little being, and I have kept hundreds, I may say thousands, in my nests. They run in and out among the ants, keeping their antennæ in a perpetual state of vibration." I have frequently noticed an insect belonging to the same species as the above, in the nests of *F. fusca* and *rufescens*. They reminded me very much of the important-looking little dogs one sees running about in the midst of a crowd on market-day. In the November issue of the Naturalist, I describe a spider which indulges in a peculiar pastime. This spider spins a web where the rays of the early morning sun strike. Through the long diameter of the web, she spins a narrow ribbon, and, as soon as the sun shines upon it, she goes out on this ribbon and promenades up and down. She never takes food caught in this web; her hunting- or trap-web is generally several feet away, but connected with her pleasure resort by a bridge.

Sometime ago I witnessed a bit of malicious sport, in which, the participants were fleas. I was observing a *Pulex* sleeping beneath the short hairs of a dog's axilla. My lens was a good one and I could clearly make out the body and limbs of the little sleeper. Suddenly there appeared another flea, which stopped short as soon as she discovered her sleeping comrade. She remained quiet for several seconds and then nimbly bounded on the others back. Clasping her body with her hind legs, she began vigorously "to touzle the hair" of her surprised sister. She then sprang away into the thicker hair, closely pursued by the thoroughly aroused and evidently angry victim of her sport.

The females of the coleopterous *Coccinellæ* frequently congregate and indulge in performances that can not be anything else save pastimes. A beech tree in my yard is called "ladybug tree" because, year after year, these insects collect there and hold their curious conventions. They caress one another with their antennæ, and gently shoulder one another from side to side. Sometimes several will get their heads together and seem by their actions to be holding a confidential conversation. These conventions always take place after

oviposition, and careful and repeated observation has shown me that they are not connected with procreation or alimentation. I have witnessed many other instances of true psychical amusement in the lower animals but do not think it necessary to detail them here. Suffice it to say, that I believe that every living creature, at some period of its existence, has its moments of relaxation from the cares of life when it enjoys the gratification of true psychical amusement.—JAS. WEIR, JUN., M. D.

ARCHEOLOGY AND ETHNOLOGY.[1]

Dr. Brinton on the Beginning of Man.[2]—Dr. Brinton contributes a characteristically readable and inconsistent artiele to the *Forum* on this subject, which is the most important and interesting among the many presented by the science of biology. It is also at the same time a prime question among archeologists, but as the archeological materials do not lend themselves to its solution, the cultivators of that science have not generally devoted much time to its investigation. Archeology begins, as Dr. Brinton says, with the evidence of human industry; that is, it begins after man had become man, and not before. It, therefore, commences where paleontologic biology leaves off, and does not embrace the question of his ancestry, which belongs to the latter science. Nevertheless, Dr. Brinton, well known as a distinguished archeologist, discusses the question of the ape-ancestry of man in an entertaining, and to some extent, instructive manner. But I have some fault to find with his article from a biological standpoint, and as it is calculated to encourage some popular prejudices, I propose to state them.

First there is to be noticed throughout, the flavor of Virchoffism, which has been so vigorously exploited by Haeckel. Virchow appears to be unalterably opposed to the hypothesis of the ape-ancestry of man, and he uses frequent opportunities of casting ridicule on it. He even goes so far as to ignore, when convenient to his argument, such evidence as there is in support of it, in a way which does not impress me with his capacity for fairness. His conspicuous fallacy is his neglect of the biological evidence for the doctrine of creation of organic species by descent, so far as regards man. This is so overwhelming, that biologists are a unit in believing in it. Man cannot be excluded, for his zoological affinities with the anthropoid apes are most pronounced. Man is not an example of an isolated type, of which many can be found among animals and plants, but his relatives are conspicuously close to him in structure, so that if evolution is true, man is one of the most evident illustrations of it. Yet Brinton says "a dozen years ago when Darwinism was at its height, an advanced scientific thinker would have felt compelled to maintain that the species man was necessarily a de-

[1] This department is edited by H. C. Mercer, University of Pennsylvania.

[2] The Beginning of Man and the Age of the Race by Dr. D. G. Brinton; *The Forum*, Dec., 1893, p. 452.

velopment of some lower mammal." I do not hesitate to say that Darwinism (i. e. evolution) was never at a greater "height" than it is at present. It is also highly uncomplimentary to the "scientific thinker" to charge him with holding views on account of the "height" of any opinion, rather than on the evidence.

The type of man of the paleolithic age, is stated by Brinton to be a fiction which "furnished imaginative writers with the compound creature they pictured in their books as our commou ancestor," etc. He then proceeds to discredit this "compound" by showing that some mistakes were made by some investigators in some points, although when he says that that the Neanderthal remains belong to a visibly diseased subject, he asserts more than has been proven. He also alleges that the depressed forehead and prominent superciliary ridges of various paleolithic skulls that have been discovered, are no indication of pithecoid origin, since they can be found occasionally among men of existing races! An argument of no value whatever, since if all low types necessarily disappeared, man would be the only animal; no monkeys ought to exist; no insects, no Amoebas! Evolution does not attempt to prove that nothing has stood still! But our author has nothing to say about the jaws of Naulette and Shipka, and the man and woman of Spy. It is on just these important remains that Virchow is silent also!

But he does have something to say on the tritubercular superior molar[3] and the lemuroid affinities of the Anthopomorpha (man and ape). Referring to the author of the present review, he says: "An eminent naturalist discovered that in a considerable number of people the tubercles on the teeth resemble those of lemurs more closely than those of monkeys. Hence he promptly drew the concluslon that the descent of man was directly from the lemurs and not from the monkeys, as the prevailing impression has been." Dr. Brinton has advanced in his views a little. He at one time declared that this statement as to the structure of the molar teeth in the higher as compared with the lower races and the apes had been "refuted" by Allen and Virchow. Soon after this, my statements were entirely confirmed by Topinard, who after a full examination of six hundred dentitions de-

[3] The reviewer of my paper in the April, '93 Naturalist on The Genealogy of Man, says of the tritubercular molar, that it is only the long known "microdontie" of civilized races. (Archiv. für Anthropologie, 1893). The reviewer evidently does not know what the tritubercular molar is nor what it signifies. It is not necessarily microdont, nor is it confined to civilized man. He has evidently not read my paper on the subject or he would not have remarked that I give no figures as to its predominant occurrence in the Esquimaux. (See Am. Journ. Morphology, July, 1888).

clared that man from having had four tubercles above and five below, would in some distant future have three above and four below. But he added that the theory of descent from lemurs is "not sustained" or "is premature." This latter question is one for paleontological biologists to decide, and Prof. Topinard did not even discuss the evidence from this standpoint. There is, however, good reason to suppose that the anthopoids (not man only) did descend from lemuroids and not from monkeys. Since Dr. Brinton's article was written, Dr. Forsyth Major has described an extinct *plistocene* lemur from Madagascar nearly as large as a chimpanzee, with tritubercular superior molars. I look for future discoveries to demonstrate the truth of the lemurine descent of the Anthropoids, and that the monkeys (Ceropithecidae) are a side branch and not in the direct line.

The descent of man from the Anthopoids is antagonized by Virchow because some of the pithecoid characters of man are not prenatal, but only appear in later growth stages and cannot therefore be inherited. And if he can find a mechanical cause for the character, so much the more certain is this conclusion in his opinion. An example of this is the ape-character found among various men ancient and modern, the platycnemic or compressed tibia. This Virchow alleges is not a mark of affinity to the apes, where it is universal, but that it is produced by a peculiar use of the muscles of the lower leg, especially of the anterior ones. This, however, only transfers the evidence from the bones to the muscles. The tibial form of the apes, it may be inferred, is produced in the same way as in man, and if it is so produced in men, we learn that in such cases the muscles and their use are like those of the apes. Prof. Virchow does not probably know, that if inheritance be believed, the entire osseous skeleton of the vertebrata has been moulded by the strains, pressures and impacts to which it has been subjected, and that these are directly or indirectly due to muscular contraction. The supposition that prognathism is not inherited from apes because it is not present in the foetus, is equally untenable. The change of shape of the relations of the cranial bones called prognathison, is common to all vertebrata, and is only delayed, more in apes, most in man.

But Dr Brinton, like many other objectors to evidence of a plain and unadorned character, has his *Deus ex machina*. "Genius is ever inexplicable" he says. True; but the shapes of bones and teeth are not, and the brains of the genius contain the structural reasons for their functions, although we have not yet seen them. "A family of, we know not which of the higher mammals, perhaps, the great tree ape, which then

lived in the warm regions of central France, may have produced a few 'sports,' widely differing physically and mentally from the parents, and these 'sports' were the ancestors of man." Here we have a theory submitted to biologists, which is not supposed to be Darwinism or apeism, and yet it bears a strong family resemblance to both. To my vision, it appears inconsistent with some of what has gone before. Its special mission appears to be, to get rid of the "missing link." But he cannot be gotten rid of so easily. "This is a theory" Brinton says "which is as good as another." But it is not as good as another, until all the ape characters of man, recent and paleolithic, are explained away. In fact I suspect that the "sporting" is altogether confined to the theory! for paleontology does not give any ground for supposing that sports have any part in the general advance which we call evolution. The process has been by the gradual accumulation of increment after increment. Besides, the "tree ape" turns out to have been a baboon!

E. D. Cope.

SCIENTIFIC NEWS.

The Danish government has decided upon a deep-sea exploration of the waters of Greenland and Iceland. The work will be carried on during 1895 and 1896. A botanist will accompany the expedition.

The American Museum of Natural History has organized an expedition, under the direction of Professor Rudolph Weber, to make collections and a scientific exploration of the Island of Sumatra.

An expedition has been organized in Australia for a scientific exploration of the mountains of Macdonnell near the centre of the continent. The party will be equipped and directed by Mr. W. Astin Horn, a wealthy colonist. The scientific corps is strong and numbers among its members Mr. Winnecke, geographer; Mr. E. C. Strisling, naturalist; Professors R. Tate and Baldwin Spencer, paleontologists; Mr. J. A. Watt, mineralogist.

The American Association for the Advancement of Science has again subscribed $100 for a table at the Marine Biological Laboratory at Woods Holl. Last year it did the same, but, we learn, some of those who should have been consulted concerning its disposition were left in absolute ignorance of any award. This year the table has certain conditions attached, which it is hoped will settle the question of responsibility. These conditions are:

1. That the table shall be known as the American Association for the Advancement of Science table.

2. That the table shall be awarded by a committee of five, consisting of the vice-president and secretary-elect of each of the two sections (F and G), and the director of the Marine Biological Laboratory (at present, Dr. C. O. Whitman).

3. That any member or fellow of the Association may apply for the table (an applicant for membership to the Association will be considered as a member and is therefore eligible).

4. Applications for the table are to be made to the permanent secretary of the Association (F. W. Putnam, Cambridge, Mass.), who will forward them to the chairman of the committee of award, the chairman being the senior vice-president of sections F and G, seniority being determined by continuous membership.

5. Holders of the Association's table will be expected to give due credit in published results of investigations carried on at the Association's table.

The death of the venerable D. C. Danielssen of Bergen, Norway, on July 13th, removes one of the ablest of the Scandanavian systematists. Most of his zoological work was done on the marine Invertebrates and was of an exceedingly careful character. He was besides a physician in regular practice, was the chief of the Leprosy Hospital at Bergen, and since 1864 has been the president of the Bergen Museum. He was born in 1815.

Gustave Honoré Cotteau, the well known paleontologist is dead, aged seventy-six. His principal work was done in the Echinodermata, of which subject he was the leading student in France.

Two of the American Arctic exploring expeditions have come to grief. The vessel of the Chicago newspaper enterprise under Wellman was crushed in the ice and some of the party returned to the Spitzbergen islands, while the leader with others was picked up and landed at Tromsoe, Norway. The Cook expedition which consisted mostly of scientific men, went in an iron vessel in oppostion to the advice of experienced arctic navigators. In her first contact with the ice a hole thirty feet long was torn in her side. She subsequently ran on a rock near to Sukkertappen and subsequently sank. The passengers were brought to Labrador by a passing vessel, but lost all their property.

The Salt Lake Literary and Scientific Association, a body incorporated for scientific pursuits, with headquarters at Salt Lake City, Utah, has recently endowed a chair of Geology in the University of Utah. The endowment is made in the handsome sum of $60,000, the proceeds of which are to be used in the support of the professorship. The chair has been named the "Deseret Professorship of Geology," and Dr. James E. Talmage has been appointed to the position. The rich collections of the Deseret Museum, belonging to the Salt Lake Literary and Scientific Association, have been placed at the disposal of the growing University of Utah. Such a movement is commendable. Utah is a rich field for the geologist, and any substantial encouragement of the science there is an effort wisely directed.

Dr. Chas. L. Edwards, lately of the University of Texas has been elected Professor of Biology in the University of Cincinnati, Cincinnati, Ohio.

☞As the year 1894 is now drawing to a close we would respectfully ask the many delinquents **to send in their subscriptions,** that we may close our books for the year with a clean bill.